NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

ESTIMATE OF MAXIMUM DETECTION RANGE FOR FLIR FROM EOMET 95 MEASUREMENT DATA

by

Chih-Li Yu

December 1997

Thesis Advisor: Alfred W. Cooper

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE December 1997	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE ESTIMATE OF MAXIMUM DETECTION RANGE FOR FLIR FROM EOMET 95 MEASUREMENT DATA	5. FUNDING NUMBERS
6. AUTHOR(S) Chih-Li Yu	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

FLIR sensor maximum range predictions for operational use may be based on the intersection of apparent target contrast temperature difference (ΔT_{app}) and sensor minimum resolvable (MRTD) or minimum detectable temperature difference (MDTD), each expressed as a function of range. Ranges obtained using the SEARAD code (MODTRAN modified for sea surface radiance) are compared with those based on Beer's Law with constant extinction coefficient. Physical and meteorological parameters for the common scenario were taken from the database of the EOMET95 measurements in Monterey Bay, with the research vessel POINT SUR as instrumented target and measurement platform. MRTD and MDTD functions were developed as functions of range for a generic Common Module FLIR using the Johnson Criterion for resolution with a parallelepiped geometry model of the POINT SUR. The Beer's Law results underestimate the SEARAD-based ranges by approximately 50% for detection but less for classification and identification. Replacement of Beer's Law with MODTRAN-computed transmittance reduces this discrepancy. SEARAD-based modeled sea radiance and short range contrast temperature show unexpected variation with range.

14. SUBJECT TERM : MDTD, MRTD, EOMET95	15. NUMBER OF PAGES 162
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

Approved for public release; distribution is unlimited.

ESTIMATE OF MAXIMUM DETECTION RANGE FOR FLIR FROM EOMET 95 MEASUREMENT DATA

Chih-Li Yu
Lieutenant, Republic of China Navy
B.S., Chinese Naval Academy, 1986

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN APPLIED PHYSICS

from the

NAVAL POSTGRADUATE SCHOOL
December 1997

Author: Yu Chih-Li
Chih-Li, Yu

Approved by: A.W. Cooper
Alfred W. Cooper, Thesis Advisor

David Dempster Cleary, Co-Advisor

William B. Maier II
William B. Maier II, Chairman
Department of Physics

ABSTRACT

FLIR sensor maximum range predictions for operational use may be based on the intersection of apparent target contrast temperature difference (ΔT_{app}) and sensor minimum resolvable (MRTD) or minimum detectable temperature difference (MDTD), each expressed as a function of range. Ranges obtained using the SEARAD code (MODTRAN modified for sea surface radiance) are compared with those based on Beer's Law with constant extinction coefficient. Physical and meteorological parameters for the common scenario were taken from the database of the EOMET95 measurements in Monterey Bay, with the research vessel POINT SUR as instrumented target and measurement platform. MRTD and MDTD functions were developed as functions of range for a generic Common Module FLIR using the Johnson Criterion for resolution with a parallelepiped geometry model of the POINT SUR. The Beer's Law results underestimate the SEARAD-based ranges by approximately 50% for detection but less for classification and identification. Replacement of Beer's Law with MODTRAN-computed transmittance reduces this discrepancy. SEARAD-based modeled sea radiance and short range contrast temperature show unexpected variation with range.

TABLE OF CONTENTS

ACKNOWLEDGMENT

This research has been supported in part by Naval Command Control and Ocean Surveillance Center, Ocean and Atmospheric Sciences Division, Code 54, under document number N6600195, Project MPB35R56S12 and partly by Naval Postgraduate school Merit Research Program funds. I would like to express my sincere appreciation to Dr. C.R. Zeisse for his guidance in operating the atmosphere propagation code (SEARAD). I would like to thank Professor A. W. Cooper for his patience, knowledge, consultation, friendship and providing constant guidance. I will always be grateful for the time we spent working together and will carry this positive and highly educational experience with me long into all my career endeavors. I would also thank Professor David D. Cleary for proofreading this work.

I. INTRODUCTION

Electro-optical and infrared sensors detect and identify targets by discrimination of their thermal contrast against the cluttered background. In the case of targets at sea, this means distinguishing the target radiance from the sea or sky background radiance, attenuated by transmission through the atmosphere, together with the radiance emitted by the atmosphere along the path. The performance of electro-optical sensors is greatly influenced by atmospheric factors related to the marine boundary layer and the scenario geometry. Polarized images of the research vessel POINT SUR (R/V POINT SUR) and of the Netherlands Oceanographic ship HM Tydeman have shown that use of a polarizer can improve contrast temperature difference ΔT against background.[Ref.1] What action is still needed is a comparison of predicted detection range with polarization and without polarization to see if the increased contrast increases the detection/ recognition range more than the loss of energy (photons) decreases it.

This thesis addresses the prediction of the detection/recognition range without polarization. The concept of the approach is that at the maximum detection/recognition range the projected apparent target background temperature difference (ΔT_{app}) must equal the apparent contrast temperature difference required by the sensor. The sensor performance is described by the parameter Minimum Detectable Temperature Difference (MDTD) or Minimum Resolvable Temperature Difference (MRTD) as appropriate. The apparent temperature contrast ΔT available at given range is computed from the zero range target temperature converted to apparent blackbody radiance, and background radiance computed using the SEARAD[Ref. 2] atmospheric propagation code, a modified form of the standard MODTRAN code. SEARAD was also used to adjust the radiance for atmospheric attenuation and path radiance. SEARAD is a DOS-compatible program developed at NCCOSC-NRaD (Naval Command, Control and Ocean Surveillance Center-Naval Research and Development) for application to naval problems.

The source of meteorological parameters for the predictions was based on the EOMET95 experiment that was conducted on May 15 to 24, 1995 in which polarized image data was recorded from Monterey Bay Aquarium Research Institute at Moss Landing, CA. The Research Vessel POINT SUR (R/V POINT SUR) was used as a target and as a measurement platform. The ship skin temperature distribution was recorded every 20 seconds throughout the experiment using a set of 15 thermistors on the ship skin. Meteorological and sea surface data measured on board the POINT SUR were used as input to the atmospheric propagation computations. The meteorological parameters and observation range selected in this experiment were used as inputs to the "SEARAD" code to calculate the atmospheric infrared (8 to 12 μm) transmittance and path radiance.

After accessing the transmittance and path radiance calculated from SEARAD, Planck's radiation law was applied to find the apparent radiance difference and corresponding temperature difference (ΔT) at the detection range. Generic common module FLIR parameters tabulated by Shumaker, Wood and Thacker [Ref. 3:p. 8-59] were used to estimate MDTD/MRTD appropriate to a generic "Marine Patrol Aircraft" FLIR sensor, and the conventional Johnsion criterion used to deduce the equivalent operational target spatial frequency.

In selecting the scenario for this analysis the ship location, heading and aspect with respect to the polarizing images in the EOMET95 image data base were collated and processed; the collated data are listed in Appendix H and Appendix I to this thesis, for later analysis. After a brief summary of the relevant radiation propagation theory, the EOMET95 experimental procedure and measurement are discussed, including the procedure for target aspect and apparent dimensions, and the computation and modeling of the FLIR, MRTD, and MDTD functions are described. Computation of target contrast and MRTD and MDTD range estimates are then described, for selected target-sensor scenarios from the EOMET95 data base and followed with discussion of the results.

II. INFRARED RADIATION FUNDAMENTALS

Optical radiation covers the ultraviolet (UV), visible, and infrared (IR) portions of the electromagnetic spectrum. The ultraviolet portion ranges from about 0.1 to 0.38 μm. The visible portion is from approximately 0.38 to 0.76 μm in wavelength. The infrared portion is divided into the near infrared or short-wavelength infrared (SWIR) region (from 0.77 to 3 μm), the middle-wavelength infrared (MWIR) region (from 3 to 8 μm), the long-wavelength infrared (LWIR) region (from 8-14 μm), and the far and extreme infrared region (from 14 to 1000 μm). The radiant energy received by an optical system from a scene object can be generally broken down into two components: (1) radiant energy due to the self-emission of the object and (2) radiant energy reflected by the object due to external radiation sources. The objects being observed by the optical system can be categorized as either the target or the background.[Ref. 4:p. 37] The radiation emitted and reflected from the target and the background traverse through the atmospheric medium, where absorption and scattering take place by molecular constituents of the atmosphere and the aerosol particles suspended in it. Re-emission and scattering from these atmospheric components also contribute path radiance to the received power. The absorption , scattering, and emission are conventionally computed using standard DOD propagation computer codes. For this study the developmental SEARAD code was used. SEARAD is described further in Appendix D.

A. THEORY OF BLACKBODY RADIATION

This section summarizes commonly known material which can be found in many tutorial sources, for example " The Infrared Handbook" [Ref. 5]. All objects with a temperature above absolute zero emit radiation. Relative spectral intensity of the radiation is dependent primarily on the temperature of the object and on the radiant properties of the material the object is made of (in particular, the spectral emissivity of the

material).[Ref. 6:p. 24] A blackbody is defined as an ideal body or surface that absorbs all radiant energy incident upon it at any wavelength and at any angle of incidence, so that none of the radiant energy is reflected or transmitted. Therefore, the term blackbody refers to a perfect absorber of radiation. Because all radiant energy is absorbed by a blackbody and none is reflected or transmitted, it will appear to be "black".[Ref. 4:p. 44]

1. Planck's Radiation Law

Planck's radiation law can be used to calculate the spectral radiance of a blackbody source. Planck's equation satisfies thermodynamic requirements and gives the spectral radiant exitance $M_{bb}(\nu,T)$ of a blackbody in terms of temperature, T, and radiation frequency, ν:

$$M_{BB}(\nu,T)=\frac{2\pi h\nu^5}{c^3(e^{h\nu/kT}-1)} \quad , \qquad 2.1$$

where

h is Planck's constant,

c is the speed of light,

k is Boltzmann's constant (1.38054×10^{-23} J-K^{-1})

This equation can also be written in terms of wavelength,λ :

$$M_{BB}(\lambda,T)=\frac{2\pi hc^2}{\lambda^5(e^{hc/\lambda kT}-1)} \quad , \qquad 2.2$$

Equation 2.1 and 2.2 express the spectral radiant exitance of a source radiating in a vacuum. For any other media, c should be replaced by the light velocity in the media, c/n, where n is the refractive index of that medium.

2. Emissivity

The radiation from all bodies in a wavelength range under consideration is dependent firstly on the temperature and secondly, in the case of non-black bodies, on the material composition and surface condition. The ratio of the emitted radiation of any

given temperature radiator to the emitted radiation of a black body of the same temperature is known as the emissivity.[Ref. 6:p. 50]

$$M=\varepsilon M_{BB} \quad , \tag{2.3}$$

3. Stefan-Boltzmann Law

The total radiated energy from a unit area of a surface in a unit of time over a 2π steradian solid angle is called the radiant exitance of that surface. For blackbody source the radiance is proportional to the fourth power of the absolute temperature of the source. This gives [Ref. 4:p.45]

$$M(T)=\sigma T^4 \quad , \tag{2.4}$$

where σ is the Stefan-Boltzmann constant $=5.6697\times10^{-12}$ W-cm^{-2}K^{-4}

For use with non-black-body sources, this law is modified by the inclusion of an "effective emissivity", ε, giving the form

$$M(T)=\varepsilon\sigma T^4 , \tag{2.5}$$

where $\varepsilon<1$. For in-band radiance, the radiance N can be calculated using the universal blackbody curve or the proportional radiation table (Appendix B) with Equation 2.6

$$N=\frac{\varepsilon\sigma T^4}{\pi}\Delta q \ , \tag{2.6}$$

where

ε = emissivity of the source.

Δq = difference of two q values from the proportional radiation table (Appendix B)

The proportional radiation $q = f(\lambda, T)$ represents the fraction of the radiant exitance emitted by a blackbody at temperature T at all wavelengths up to the selected value of λ. It can be described in Equation 2.7

$$q=\frac{\int_0^{\lambda} M(\lambda,T)d\lambda}{\int_0^{\infty} M(\lambda,T)d\lambda} \ , \tag{2.7}$$

If q values are not shown on the table, they can be calculated by interpolation between two q value entries.

4. Kirchhoff's Law

When radiation is incident upon a body, some of it is transmitted, some absorbed, and some is reflected. Thus, the ratios of each of these to the incident power must add up to unity [Ref. 11:p. 1-29] given

$$\alpha(\lambda)+\rho(\lambda)+\tau(\lambda)=1 , \qquad 2.8$$

where

$\alpha(\lambda)$= spectral absorptivity

$\rho(\lambda)$= spectral reflectivity

$\tau(\lambda)$= spectral transmissivity

5. Lambert-Beer Law

Atmospheric transmittance is a function of wavelength, which can be described by the Lambert-Beer law

$$\tau(\lambda)=e^{-\mu R} , \qquad 2.9$$

where $\tau(\lambda)$ = spectral atmospheric transmittance,

λ = wavelength,

μ = extinction coefficient,

R = path length.

The extinction coefficient depends on the atmospheric molecular composition and aerosol concentration.

B. INFRARED RADIATION SOURCES

Optical sensors function by sensing the radiation emitted by an object or the radiation reflected from the object being illuminated by an external radiation source. Detection of a jet engine plume by an infrared detector is an example of the first category

whereas the visible detection of an area illuminated by the sun is an example of the second category. In both cases these sensors are passive, as they do not generate their own power. Active sensors on the other hand generate their own power and detect targets from the reflected energy of this power. Electro-optical systems may operate using natural and artificial sources of power.

C. ATMOSPHERIC PROPAGATION OF INFRARED RADIATION

The attenuation of optical radiation due to the atmosphere arises from the individual or collective effects of the following phenomena

1. Molecular absorption
2. Molecular scattering
3. Aerosol absorption
4. Aerosol scattering

The two main causes of attenuation, however, are molecular absorption by several minor constituents of the atmosphere and scattering due to atmospheric molecules and the particles in the present atmosphere (aerosols). Molecular absorption occurs mainly in several more or less narrow absorption bands and is due to transmittence in certain molecules, matched to that transition from one state of vibration and rotation to another, thereby absorbing or emitting a photon.[Ref. 4:p. 75]

1. Absorption Effects

Radiation absorption due to molecules in a gaseous medium can be divided into two processes:

(1) Atomic absorption is due to the transition of electrons in an atom, and usually requires a photon with an energy of a few electron volts. It generally takes place in the visible or ultraviolet region of the spectrum.

(2) Molecular absorption is due to a transition between electronic, vibrational, or rotational energy states of a gas molecule or due to a combination of all of these. This mechanism is dominant in the infrared range.[Ref. 4:p. 76]

2. Scattering Effects

Scattering is the process by which the energy in an electromagnetic wave is intercepted and reradiated into 4π steradians solid angle. It results from the interaction of the wave field with the electron oscillators in the scattering medium. These are excited by the incoming wave field, behaving as forced harmonic oscillators which reradiate at the frequency of the incident wave. The secondary wave, however, shows a phase lag from the primary dependent on the difference between the wave frequency and the oscillator resonance frequency. Any inhomogeneity in refractive index can cause scattering; in the atmosphere the component gas molecules, aerosol particles of various sizes, and fog, rain and hail drops are all effective scatters. The spatial distribution of the scattered radiation is strongly dependent on the relative magnitudes of the particle size and the wavelength. For particles very small compared with the wavelength, the scattering is approximately isotropic; as the ratio of size to wavelength increases, the scattering is concentrated more into the forward hemisphere. For very large scattering objects forward scattering dominates, and secondary lobes develop at other angles in the radiation pattern. In the small particle regime, the scattering can be described by the relatively simple theory developed by Rayleigh, which predicts scattering proportional to the second power of the volume of the wavelength. This describes scattering by atmospheric molecules. For particle sizes greater than one tenth of the wavelength, the Rayleigh approximation is no longer adequate; the more comprehensive Mie theory (1908) is required.[Ref. 7:p. 12-22]

a. Rayleigh Scattering

When the atmosphere does not contain large size particles, but only the

molecules of its gaseous constituents, the scattering phenomenon is dominated primarily by these molecules. The intensity of the scattering depends on the number and index of refraction of these gaseous molecules and on the scattering angle, wavelength, and polarization of the incident radiation. The attenuation of a light beam due to Rayleigh scattering is expressed by

$$I=I_0\exp(-\sigma_m R) \quad , \qquad 2.10$$

where

I_0 is the magnitude of the original radiation

I is the magnitude of the scattered radiation

σ_m is the Rayleigh scattering coefficient

R is the path length

The Rayleigh scattering coefficient σ_m is the product of two parameters

$$\sigma_m=\sigma_r N \ , \qquad 2.11$$

where

σ_r is the Rayleigh scattering cross section,

N is the molecular density.

The Rayleigh scattering cross section, σ_r , is defined as the cross section of an incident wave, so that the total power scattered by a gaseous molecule in all directions is equal to the power flowing across the cross section. It is given by the expression

$$\sigma_r=\frac{8\pi^3(n^2-1)^2}{3N^2\lambda^4} \ , \qquad 2.12$$

where

n is the index of refraction of the gaseous medium

N is the molecular number density.

Note that the scattering cross section σ_r is a function of wavelength and proportional to λ^{-4} . It therefore dominates more in the ultraviolet and visible regions than in the infrared region. The formula also indicates that σ_r is a function of the index of refraction of air and molecular number density.[Ref. 4:p. 78]

b. Mie Scattering

Aerosol scattering, or Mie scattering, is concerned with the radiation interaction with spherical particles of various sizes. The transmitted beam irradiance here, similar to Rayleigh scattering, is expressed by

$$I = I_0 \exp(-\sigma_a R) \,, \qquad 2.13$$

where I, I_0, and R are as defined previously, and σ_a is the aerosol attenuation coefficient, which is a function of aerosol density. Aerosol size distribution does not change much with altitude, whereas the aerosol density does. The relationship for aerosol attenuation coefficient at altitude h is given by

$$\sigma_a(h) = \frac{M(h)}{M(0)} \sigma_a(0) \,, \qquad 2.14$$

Where M(h) denotes the aerosol number density at height h and $\sigma_a(0)$ is the aerosol attenuation coefficient at sea level.[Ref. 4:p. 81] These absorption and scattering losses must be compounded when treating propagation through the atmosphere.

III. EOMET95 EXPERIMENT AND DATA COLLECTION

A. INTRODUCTION

The data for this thesis were obtained from an ocean field experiment conducted from 15 to 24 May 1995 off the coast of Monterey. The EOMET 95-Spring Cruise involved the R/V POINT SUR, which supported shipboard measurements of atmospheric and oceanic planetary boundary layer data made by the NPS Boundary Layer Meteorology group. In addition, measurements from stationary platforms located in Monterey Bay and its shoreline were collected. The R/V POINT SUR is a 135 foot ship (dimension: 41.5L×9.75W×8.8H (m)) owned by the National Science Foundation and operated by Moss Landing Marine Laboratory. Of particular interest was the availability of the POINT SUR during the mornings of the cruise for imaging operations, which placed the ship at various ranges, and aspect angles, which enabled the collection of polarized IR imager data coincident with the environmental measurements. During these operations, measurements were made of the degree of polarization and contrast improvement factor for ship images as a function of range and aspect angle. The environment impacts these measurements in the following ways:

(1)The observed wave spectrum and wind speed/direction affects the sea surface degree of polarization.

(2)The SST (Sea Surface Temperature) and air temperature impacts the target to background contrast.

(3)The air temperature, humidity, and aerosol content affect the IR path radiance and extinction coefficient.

B. DATA MEASUREMENTS

1. Imaging System

The NPS AGA 780 Thermovision Thermal Imaging System was set up and operated from Moss Landing. The site was the MBARI Building located at approximately 6 meters above sea level. The estimated horizon range from this location was 4.5 nautical miles. The AGA 780 imaging system is a dual band serial scanning infrared imager capable of operation in the 3-5 and 8-14 micron bands. The system utilizes a 7×7 degree field of view lens or an optional 3.5 degree lens for each channel to focus incoming infrared radiation through a polarizing filter wheel, then through a dual rotating prism system onto the corresponding detector. The detectors are cooled to 77 K by dewars filled with liquid nitrogen. The filter wheel was rotated to provide vertical, horizontal and zero polarization settings during data collection. The detectors produce a current, which is called "thermal value" and is proportional to the intensity of the radiation received. The signal is then amplified and converted into a video signal for monitor display.

2. Calibration Technique

The AGA 780 imaging system was calibrated with a laboratory blackbody source. The system output or "thermal value " is recorded against the blackbody temperature through a range of temperatures. A calibration curve is generated which takes into account the scanner, lenses and filters (Moretz, 1994). All the data collected during EOMET 95 Spring Cruise was either calibrated or can be calibrated.

3. Target Temperature

To provide a means of determining target temperature, the R/V POINT SUR was instrumented with thermistor temperature sensors at numerous points on the ship's skin. Each thermistor was fastened to the skin by use of beryllium adhesive, which is extremely conductive. The thermistor was then covered with white epoxy to assure

maximum albedo from sunlight. The sensors were linked by shielded cable to a data collection computer in the instrumentation spaces aboard ship.

4. Visual Imaging

Coincident images in the visual range were made from the IR imager site at the MBARI building. These were made with a high quality video recorder system. The polarization analysis of these data will be presented in a further report or thesis.[Ref.8]

IV. MRTD AND MDTD

Minimum Detectable Temperature Difference (MDTD) and Minimum Resolvable Temperature Difference (MRTD) are two standard descriptions of FLIR performance. They are defined as those temperature contrast differences which make a standard bar chart just resolvable or a square target just detectable, respectively, to a trained observer. Each of these provides a sensitivity measurement of the FLIR system. Both of them employ the concept of the Equivalent Blackbody Temperature of a non-blackbody object. The equivalent blackbody temperature is that temperature a blackbody must have to emit the same radiance as the target. This allows the use of a single value to represent the target's temperature and emissivity. To complete the comparison of apparent ΔT with the system performance ΔT requires numerical values of these quantities as functions of spatial frequency and range.

A. MINIMUM RESOLVABLE TEMPERATURE DIFFERENCE

MRTD (often also abbreviated MRT) is a function of spatial frequency. It gives the ΔT between the hot (cold) and ambient temperature bars of a standard 4 bar (7:1 aspect ratio) chart required to make the bars just resolvable as a function of the spatial frequency of the bars. MRTD is a measure of the performance of the entire FLIR system. Since the MRTD includes the observer, the measurement is subjective. The computed system MRTD shows an asymptotic value beyond which the detector angular subtense is greater than the reciprocal of the spatial frequency, or the "spatial period" and finer detail cannot be distinguished. For a typical FLIR (Common Module), the instantaneous field of view (IFOV) is approximately 0.25 mRad so that the in-scan detector subtense Δx is approximately 0.25 mRad and the cut off spatial frequency (asymptote) is approximately $1/\Delta x=1/0.25=4$ cyc/mRad. If we use the "rule of thumb" asymptote between $0.7/\Delta x$ and

$0.9/\Delta x$, we would find that the asymptote is approximately 3 cyc/mRad. The effective IFOV depends on the magnification of the optics that may be variable in some FLIRs.

Shumaker[Ref. 3:p. 8-52] gives a typical form for the MRTD.

$$MRT(v) = \frac{2\ \text{SNRT}\ \text{NET}\ \rho_x^{1/2}}{\text{MTF}_S(v)} \left[\frac{v^2 \Delta x \Delta y}{L}\right]^{1/2} \left[t_e F_r N_{os} N_{ss}\right]^{-1/2}, \qquad 4.1$$

where SNRT = signal to noise ratio threshold,

NET = noise equivalent temperature,

ρ_x = noise filter factor,

Δx = in-scan detector subtense (mRad),

Δy = cross-scan detector subtense (mRad),

MTF = modulation transfer function,

ν = spatial frequency for which MRT is desired in cyc/mRad,

L = length-to- width ratio of the bar (7),

t_e = eye integration time in seconds,

Fr = frame rate s^{-1},

N_{os} = overscan ratio,

N_{ss} = serial scan ratio.

Shumaker [Ref.3:p. 8-7] also provides an expression for the Noise Equivalent Temperature Difference (NET_D), the target apparent contrast ΔT which yields an output SNR of 1, as

$$\text{NET}_D = \frac{10\left(\text{FOV}_x\ \text{FOV}_y\ \text{F}_r\ \text{N}_{os}\ \text{N}_{ss}\right)}{\left(\pi\ \text{N}_D \eta_{SC}\right)^{1/2} \text{D}\Delta x \Delta y \text{D}^{**} \eta_{CS} \,{}^{\partial \text{N}}\!/_{\partial \text{T}}\, \tau_0}, \qquad 4.2$$

where FOV_x = in-scan FOV in mRad,

FOV_y = cross-scan FOV in mRad,

N_D = number of detectors,

η_{sc} = scan efficiency,

$\partial N/\partial T$ = derivative of Planck's equation in W/cm^2 –K-Sr,

D**	=	the band average detectivity in cm $Hz^{1/2}$ /W,
D	=	aperture diameter in meters,
τ_o	=	transmission of the optics.

B. MINIMUM DETECTABLE TEMPERATURE DIFFERENCE

The MDTD of a FLIR system gives the temperature difference between an isolated square target and a uniform background that renders the square just detectable, as a function of the size of the square. In order to maintain similarity between graphs of MDTD and MRTD, MDTD is plotted as a function of the spatial frequency and range. Shumaker [Ref.3:p. 8-67] provides a typical form for MDTD

$$MDT(v) = \frac{(\mathrm{SNRT})\,(\mathrm{NET})\left(\Omega_T + r_S^2\right)(\Delta x \Delta y)^{1/2}}{\Omega_T\left[\frac{\pi}{4}\left(r_S^2 + r_B^2 + \Omega_T\right)t_e F_r N_{os} N_{ss}\right]^{1/2}} \quad , \qquad 4.3$$

where Ω_T = target angular subtense ($mRad^2$),

r_s = system resolution (mRad),

r_B = back-end resolution (mRad).

The other definitions of the parameters in Equation 4.1 such as SNRT, NET, Δx, Δy, t_e , F_r, N_{os}, N_{ss}, are the same.

C. MRTD AND MDTD COMPUTATION

Shumaker[Ref.3:p.8-59] provides the following set of parameters that are postulated to be appropriate to the Common Module FLIR in NFOV (Narrow Field of View) mode. $\rho_X=(1+(2v\bullet r_B)^2)^{-1/2}$ is computed from the equivalent back-end resolution r_B which is given for this example as 0.335 mRad.[Ref. 3:p. 8-60] The resulting

computation from MATLAB is shown in Figure 5 which shows MRTD and MDTD vs spatial frequency. MATLAB code is shown in Appendix J section B.

FOV_X	6.86^0	FOV_Y	5.16^0	L	7
F_r	30 sec^{-1}	N_{os}	1	r_E	0.3 mRad
N_{ss}	1	N_D	180	r_d	0.08
η_{sc}	0.75	τ_0	0.70	N_s	2
t_e	0.1 sec	SNRT	2.5	MTF	Tabulated
f	0.20 m	Δy	0.25mRad	D^*	4×10^{10}
D	0.10 m	Δx	0.25 mRad	NET	0.1°K

Table 1. Parameters of NFOV FLIR

Spatial Frequency (ν) (cyc/mRad)	Δx= 0.25 mRad MTF
0.00	1.00
0.25	0.89
0.50	0.79
0.75	0.64
1.00	0.53
1.25	0.43
1.50	0.35
1.75	0.27
2.00	0.20
2.50	0.10
3.00	0.04

Table 2. MTF for NFOV

V. DATA COMPUTATIONS AND ANALYSIS

A. APPARENT ΔT COMPUTATION

1. Data Summary of Infrared Measurements in EOMET95

The intent of the infrared imaging measurements made during the EOMET95 cruise was to observe the variation with range of the sea surface degree of polarization and of the apparent target/background temperature contrast improvement with polarization filtering for the R/V POINT SUR, and to attempt to observe emission polarization effects on facets of the ship image. To attain these ends the available ship operation periods were allotted alternately to two series of measurements;

(1) Rotation of the POINT SUR by small increments of heading angle through 360° at fixed range and bearing from the sensor, for a selection of ranges and bearings. For each target aspect and range images were recorded with vertical and horizontal polarizing filter and no polarizer.

(2) Recording of vertical and horizontally polarized and unpolarized images of the POINT SUR at selected aspect at a set of selected ranges along a constant bearing line to a maximum observation range.

Reference ship skin and sea and air temperature measurements were recorded during the entire observation period, as described below. Global Positional System (GPS) data for ship heading and position and radiosonde vertical atmospheric profiles were recorded on the R/V. POINT SUR. These values were accessed with the assistance of the NPS Boundary Layer Meteorology Group. The appropriate data selections are included in the appendices to this thesis.

For the purposes of this thesis certain data points were selected from this extensive data base, for calculation of predicted detection or recognition range.

2. Ship Temperature Computation

Ship skin temperature samples were collected from 15 thermistors attached with epoxy cement to the surfaces of the larger facets of the ship, located and distributed as indicated on Figure 12 and 13. The thermistor voltages were recorded continuously at 20 second intervals. The records were listed by time entries in seconds from midnight GMT for each day. These temperature files are listed in Appendix A. The format of the output files is illustrated by the sample file of Table 3. In each file the first header line gives the file name. The second line gives the Month, Day and Year from the computer clock, followed by the Hour, Minute and Second of the file on the next line. The next line gives the DAC voltage (digital value), start channel, stop channel, number of samples averaged, and reference channel number on each board. Note that thermistor channels 1 and 9 always read 25.00 ° C since they are reference channels. The position data used in this analysis (extracted from the ship GPS data file listed in Appendix H for the period of IR measurement) are for the period from approximately 1830 to 1840 May 16 1995 GMT.

```
May 16.1
 Mon,Day,Year=   5  16 1995
 Hour,Min,Sec=   8  27  36
 volts,istart,istop,nsam,iref 1.49939  1  16  100  1
  1326456 25.001 12.856 13.403 11.963 14.615 11.677 12.359 11.634 25.001 14.242
22.956 12.010 11.617 11.431 15.410 25.874
  1326476 25.001 12.864 13.397 11.959 14.646 11.673 12.371 11.633 25.001 14.200
22.937 12.001 11.607 11.426 15.229 25.535
```

Table 3. File Identification for Ship Temperature Thermistor Reading

These thermistor readings provide ship temperature at selected points; from these an average ship temperature must be derived as input to a range estimation. This has been

done by comparing previous detailed radiometric measurements made of the temperature distribution over images of the R/V POINT SUR [Ref.9] with the concurrent thermistor spot temperature. From these data each facet area on the ship profile has been correlated with a representative thermistor location, as shown in Figure 13. Based on this correlation, an area weighting factor is assigned to each recorded thermistor temperature and a weighted average temperature computed for the appropriate ship aspect. While it is realized that the temperature distribution will change with change of ship operating conditions and meteorological conditions, this gives a relatively simple technique for modeling the ship signature, roughly comparable to methods previously used in Tactical Decision Aid models, and has been used here for the input ship temperature for the sample case. Table 7 shows ship average temperature for computation by equation 5.1.

$$\text{Average temperature} = \frac{\sum T_i \Delta A_i}{\sum A_i}, \qquad 5.1$$

3. Ship GPS Position and Heading Data Correlation

The times of recording of the ship GPS data and the skin temperature data are not synchronized. The temperature is recorded every 20 seconds while the position is recorded every 10 minutes. For accuracy in target signature modeling, recorded simultaneous ship heading and position values are selected from the GPS files (Appendix H), and the appropriate temperature values interpolated from the temperature files (Appendix A). As an example, to compute a detection/recognition range for the target at heading 120 degrees, the ship location and atmospheric parameters are interpolated between the measurement points in Appendix H closest to that heading, those entries highlighted in Appendix H. Data were recorded at 1830 GMT at heading 172 degrees, and 1840 GMT at 106 degrees. Interpolating to 120 degrees assuming a constant rotation rate of 66 degrees in 10 minutes, or 0.11 degrees per second, gives us a time of 18:37:53 GMT or 11:37:53 local time. To read the corresponding skin temperatures we convert this

time into seconds after the start of file at 08:27:36 at file number 1326456. This lapse time of 11416 seconds corresponds to file number 1337872. The closest skin temperature set to this is file number 1337876, shown in the sample listing below, highlighted in Appendix A, Page 65. It is assumed that no significant changes in meteorological parameters will occur in the 4 seconds discrepancy, so that the data selected for this time will form a consistent set.

1337856 25.001 16.392 17.862 17.334 15.415 15.885 14.338 15.873 25.001 18.294 24.326 15.281 16.169 15.352 22.299 28.721

1337876 25.001 16.423 17.864 17.291 15.361 15.830 14.368 15.909 25.001 18.333 24.164 15.296 16.151 15.346 22.393 28.829

1337896 25.001 16.458 17.844 17.241 15.295 15.771 14.383 15.946 25.001 18.366 24.093 15.304 16.117 15.305 22.319 28.933

Table 4. Thermistor Sample Output File

Side	Σ Pixel	Σ Temperature	ΣTemperature /ΣPixel = Average Temperature
Port	59	976.196	16.54569
Starboard	59	1028.287	17.42859
Total Average Temperature	118	2004.483	16.98714

Table 5. Ship Average Temperature vs Pixel for the Sample Case Selected

4. Temperature and Radiance Conversion

The average of ship temperature computed for this sample period is 273 + 16.987144 = 289.987144 K. Ship temperature and sea background temperature were

converted to in-band radiance by application of the Planck function. The ship temperature is then converted to in-band radiance N_s at zero range

$$N_s = \varepsilon\sigma T^4 \Delta q/\pi$$

$$= 0.95\times5.6697\times10^{-8}\times(289.98714)^4\times0.2486117/\pi = 30.14347844\ (\mathrm{W/m^2Sr})$$

where

ε=0.95, emissivity of R/V POINT SUR and Δq=q2-q1 is the fraction of the thermally emitted radiance lying in the band from λ_1 to λ_2 at source temperature T.

$\lambda_1 T = 8\mu\times289.98714 = 0.23198971$ cm$\times$K =>q1= 0.1314394

$\lambda^2 T = 12\mu\times289.98714 = 0.3479845$ cm$\times$K =>q1= 0.3800511

and Δq=q2-q1 =0.2486117

The q values have 5 digits as reported in the radiation table (Appendix B) to keep the fraction of the radiant exitance as close as possible to the integral of Planck's Law.

5. Transmittance and Path Radiance

The SEARAD program was used to obtain the transmittance and path radiance between the target and the FLIR sensor. Appendix D describes how to install SEARAD and to run the example case. There are some points which need to be noted carefully when inserting radiosonde profile data in the input data file. The maximum number of atmospheric levels that can be inserted is 34. The position of every data point is important for SEARAD, so it is essential that each must be inserted in the correct column and row of the input table. The Windows text editor may cause a problem after the data have been inserted and saved. It is recommended that we use the simplest editor available (i.e. the MS-DOS editor). To run SEARAD it is not necessary to follow all the steps listed in Appendix D. "Tape 5" is the data file which will be read into SEARAD and executed; thus we need only modify the "Tape 5" data. The necessary steps to run SEARAD are shown below:

- Go to DOS program; it should show C:WINDOWS> .
- Under C:WINDOWS type "cd c:\".

- When it shows C:> then type "cd searad".
- It shows C:\searad> then type "edit tape5".
- It shows MS-DOS editor.
- Modify the data and save it; then exit.
- It should return to C:\searad>.
- Under C:\searad> type "searad" which means to execute SEARAD.
- We can use WORD or WORDPERFECT to read the output file "out" under the SEARAD directory.

The inputs of the SEARAD code are tabulated in Appendix F. The transmittance for this typical case is τ =0.735 and path radiance N_p= 7.58028 W/m²Sr. Ship radiance N_{s+p} at full range $=N_s\ \tau + N_p$

$$N_{s+p}=N_s\tau+N_p=30.14347844\times0.735+7.58028=29.7357366\ (\mathrm{W/m^2Sr})$$

It is necessary to convert target radiance at maximum range to equivalent blackbody temperature. In-band radiance at full range can be converted into equivalent blackbody temperature by use of Planck's radiation law using an interactive computer program and look-up table as shown in Appendix C. As an example, when N_{s+p} = 29.7357366 W/m²Sr, the effective T_{s+p} = 284.68 °K. From the SEARAD output (Appendix G shows a typical case), the background radiance N_b at full range is 21.93238 W/m²Sr. By conversion with the computer program in Appendix C, the corresponding apparent temperature is found to be 268.7 K. The apparent temperature difference at full range is then T_{s+p} -T_b =15.98 °C. The whole data set for the typical case are shown in Table 8.

B. MRTD AND MDTD VS RANGE COMPUTATION

1. Range, Elevation and Azimuth Angle

From GPS data (Appendix H) we must compute range and elevation and azimuth angles. There is a 7 hours time difference between GMT and local time (PACIFIC Summer Time). For example the time of 0800 for Monterey will be 1500 for GMT.

Appendix H contains the GPS data, for the time period in which the experiment took place. Figure 3 and 4 show the orientation of the ship and relation between bearing angle and ship's aspect. Since we treat the ship bow and stern aspects as the same, we only consider heading from zero to 180 degree in this thesis.

dx = (ship longitude)-(sensor longitude) (nmi)

dy = (ship latitude)-(sensor latitude) (nmi)

α = arctan (dx/dy) (degree)

range $= \sqrt{dx^2 + dy^2}$ (nmi)

θ = arctan ((sensor altitude) / range) (elevation angle)

To compute bearing we need to consider two different kinds of situation; those in which the ship is to the north or south of the sensor position. Range is computed by conversion of GPS location difference into distance.

a. Condition 1

dy>0. This is illustrated by Figure 3.

If heading > 180 - α , then β (bearing) = heading –180 + α

If heading < 180 – α , then β = 180 – α - heading

b. Condition 2

dy<0. See Figure 4.

If heading < α , then $\beta = \alpha$ – heading, if heading > α, then β = heading – α

If $\beta < 90$ then $\phi = 90 - \beta$, if $\beta > 90$ then $\phi = 180 - \beta$

1 degree latitude at 37 degree N latitude is 59.97 nmi

1 degree longitude at 37 degree N latitude is 47.995 nmi

1 nmi (nautical mile) = 1.852 km =1852 m

The computations are described in Appendix J section A,"MATLAB" code. After computation with previously selected data (see Table 8) we have:

$\alpha = 38.6737$ (degree)

β (bearing) = 21.3263 (degree)

range = 0.7681 (nmi) = 1.4225 (km)

$\phi = 1.1985$ (rad) (azimuth angle)

$\theta = 0.0042$ (rad) (elevation angle)

2. Projected Area of the Ship A_t

From previous calculation we compute projected area.

$$\begin{aligned} A_T &= lw\sin\theta + hw\cos\theta\sin\phi + hl\cos\theta\cos\phi \\ &= 41.5 \bullet 9.75 \bullet \sin(0.0042) + 8.8 \bullet 9.75 \bullet \cos(0.0042)\sin(1.1985) + 41.5 \bullet 8.8 \bullet \cos(0.0042)\cos(1.1985) \\ &= 214.4513\ m^2 \end{aligned}$$

where

$$\begin{aligned} l &= 41.5 \text{ m (ship length)} \\ w &= 9.75 \text{ m (ship width)} \\ h &= 8.8 \text{ m (ship height)} \\ \phi &= 1.1985^{0} \text{ (azimuth angle)} \\ \theta &= 0.0042^{0} \text{ (elevation angle)} \end{aligned}$$

Figure 1 shows the orientation of a ship target model for calculating the projected area.

3. Critical Dimension D_c

The comparison of the temperature contrast of a ship target with the standard "bar target " for which the performance parameter MRTD is derived requires the definition of an equivalent resolved spatial frequency required on the target image for target recognition (or detection). In applying the long standing Johnson criterion [Ref.3:p. 2-7] of resolved cycles on the target, we adopt Moser's [Ref. 3:p. 2-6] convention for the "critical dimension" of the ship $= \sqrt{A_T} = 14.64$ m. Dividing the critical dimension D_c by the number of equivalent bars N on the target gives the physical dimension χ to be resolved (ie. pixel length) to accomplish the task, i.e. $\chi = D_c/N$. From the Johnson Criterion (see Table 6), the number of bars N necessary for pure detection, $N = 1$. The number of bars N necessary to classify the ship is 4 cyc × 2 bars/cyc = 8 bars. The number of bars N necessary to identify the ship is 6.4cyc x 2 bar/cyc = 12.8 bars. The one dimensional resolved "footprint " required on the target is then:

a. For detection the physical dimension $\chi = D_c/N = 19.3/1 = 14.64\ m$

b. For classification the physical dimension $\chi = D_c/N = 19.3/8 = 1.83\ m$

c. For identification the physical dimension $\chi = D_c/N = 19.3/12.8 = 1.144\ m$

Discrimination Level	Cycles Across Minimum Dimension	Number of Bars
Detection	1.0	1.0
Classification	4.0	8.0
Identification	6.4	12.8

Table 6. Johnson Criterion [Ref. 5:p. 54]

4. Conversion of Spatial Frequency to Range

The fundamental spatial frequency f_c characterizing the ship can be written in lines per milliradian as

$$f_c = \frac{R}{2000\chi} \text{ (cyc / m Rad)} , \qquad 5.2$$

where R is the range in meters from sensor to target. The relation of the spatial frequency to range R and physical dimension χ is shown in Figure 2. The MRTD and MDTD curves as a function of spatial frequency in NFOV for a generic Common Module FLIR have been given in Chapter IV and are shown plotted in Figure 5. The spatial frequency vs range relationship of Equation 5.1 has been used with Equation 4.1 and 4.2 to compute MRTD and MDTD vs range, for the R/V POINT SUR as target, using the required "cycles per critical dimension" N_c, in the form $\chi = D_c/N_c$, where N_c expresses the Moser definition of "critical dimension". The detailed calculations are in Appendix J, "MATLAB code". Figure 6 shows MRTD and MDTD for detection as function of range, for the R/V POINT SUR as target. The target available contrast temperature difference against background ΔT_{app} is also shown on the same range scale. The intersection points of ΔT with the MRTD and MDTD curves yield the maximum ranges for detection according to the two criteria. Figure 7 shows the corresponding MRTD for classification of the R/V POINT SUR, according to the Johnson criterion of required resolution line pairs on the critical dimension. MDTD cannot be used for classification. Figure 8 shows the equivalent curve for MRTD for identification of the POINT SUR. The value of $\Delta T_{app}(R)$ in these three figures is the simple estimate of ΔT_0 multiplied by the transmittance (see Section VI. A).

VI. DATA ANALYSIS AND CONCLUSIONS

The computations of target temperature difference ΔT, MDTD and MRTD for the experiment are described in the previous chapter. Meteorological data (including radiosonde measurement) for SEARAD code inputs were taken from the meteorological data that were recorded during the experiment, and are shown in Appendix H and Appendix I. The estimated MRTD curve and MDTD curve were derived from Shumaker's example 8-13[Ref. 3:p. 8-59] for a generic FLIR system in NFOV. The NET was chosen as 0.125 K, between 0.1 K to 0.25 K, due to degradation of the FLIR sensor after being in service for several years. This sensor is a generic common module FLIR model, with the parameters of Table 2. The condition for detection at maximum range is that the apparent target/background temperature difference as modified by atmospheric path attenuation and path radiance will match the required MDTD or MRTD at the same range. We have already expressed the MRTD and MDTD parameters as functions of range. We are now required to calculate the apparent temperature difference between target and background as a function of range from the target. Two methods of differing complexity are available for this computation; the greatly simplified approach of assuming that the temperature difference ΔT attenuates through the atmosphere in the same way as the irradiance, and the more complicated but more rigorous approach of converting the ΔT into a radiance difference, computing the transmitted radiance difference due to attenuation and path radiance, and reconverting ΔL back to ΔT_{app} through inversion of Planck's Law. Sample computations of both types have been made. These are compared in the following paragraphs, using the sample atmospheric data set of Table 8.

A. APPARENT ΔT BY ATTENUATION OF SOURCE ΔT

SEARAD with the "typical case" (see Table 8) scenario is found to give a transmittance of 0.735. Transmittance, averaged over a bandwidth which does not contain absorption edges, typically is written as an exponential function of range following Beer's Law. From transmittance we calculate attenuation coefficient averaged over the assumed bandpass of 8 to 12 μm, of

$$\tau = e^{-\mu R} \quad => \quad \ln\tau = -\mu R \quad => \quad \mu = \frac{-\ln\tau}{R}$$

$$0.735 = e^{-\mu R} \quad => \quad \ln(0.735) = -\mu(1.444\text{km}) \quad => \mu = 0.2132\ \text{km}^{-1}$$

For transmittance $\tau = 0.735$ over a range of 1.4444 km for horizontal range 1.4225 km, the attenuation coefficient $\mu = 0.2132\ \text{km}^{-1}$. The apparent temperature difference as a function of range is then computed with the form $\Delta T \times \tau(R) = \Delta T \times e^{-\mu R}$ using MATLAB. For a given target, the functions MRTD, MDTD and ΔT_{app} can be plotted on the same scale as functions of range. The intersection of the ΔT_{app} plot with the appropriate MRTD or MDTD curve occurs at the maximum range for the detection, classification or identification, according to the defined criterion. Figure 6 shows The MRTD-derived detection range as 21 km and the MDTD-derived value as 19 km. The classification range (from MRTD) is seen in Figure 7 to be 8.8 km. Figure 8 shows identification range as 6.2 km.

B. RADIANCE COMPUTATION METHOD

The second method of computation of effective ΔT is to convert the target and background temperatures to radiances, and compute the attenuated ΔT and appropriate path radiance for selected range, and reconvert the result into ΔT_{app}. This method was applied for a set of ranges appropriate to the measurement scenario and data set. Tables 9.1 to 9.5 show a tabulation of the computed parameters for the sensor elevation of 6 meters, the AGEMA imager location at Moss Landing. The locations were selected from

those for which observed images were recorded in EOMET95, so that the results may later be applied to comparisons of polarization. All the computed components of ΔT, the difference between the apparent values of ship average temperature corrected for attenuation and background temperature, are shown in this table. The independent variable is the zenith angle, used to define the path geometry for this sensor location. The zero range ship radiance is also input. The SEARAD program computes the corresponding range, transmittance and path radiance, and apparent ship radiance, and the background radiance. The radiance contrast is then converted back into temperature difference. Table 9.5 shows an anomaly in range and a path that does not intersect the sea surface beyond 13.3 km; this range defines the effective horizon for the selected sensor elevation of 6 meters. It follows that we cannot compute predicted maximum range for detection or recognition for ranges greater than this. To allow range predictions to be extended to greater ranges a further set of data was computed, for sensor elevation raised to 250 meters. This allows us to see range limitation by atmospheric effects rather than by geometry. The results of these computations are shown as Tables 10.1 to 10.6. From these tables we can see that ΔT attenuates almost to zero at long range. ΔT is shown plotted against range in Figure 9 and Figure 10. Figure 9 represents the original situation with sensor at 6 meters elevation; Figure 10 represents the same target and atmospheric scenario, but with the sensor raised to an elevation of 250 m. This revised curve allows the intersection of the ΔT(R) curve with MRTD(R) to be observed, and the Maximum Detection Range extracted. This curve is shown as Figure 11. Figure 14 shows ΔT vs MRTD for classification and identification. The apparent MRD is 44 km.

C. SEARAD

The SEARAD code input file requires the meteorological data inputs wind speed (W_S), wind direction (W_D), visibility (VIS), air mass character (AM) and the sea temperature. A sample input file for SEARAD is shown in Appendix F. The contents of the three header lines in Appendix F are defined by the "cards" listed in Appendix E.

Since SEARAD reads in the data it must to be in the correct column and row. The sample input file shows "card 2C1" which is for radiosonde data to be inserted. The last digit of the layer altitude must to be in column 10 and the last digit of pressure must be in column 20. The last digit for the temperature of the layer boundary must be in column 30 and the last digit of the relative humidity must be in column 40. The designated specific units must be in columns 61, 62 and 63. From the sample input file we can see they should be lined up column by column and row by row. The sample output from SEARAD (atmospheric transmittance τ and path radiance Np) are shown in Appendix G. To read in a new model atmosphere from radiosonde data, the sensor's altitude can not be greater than the upper layer boundary. SEARAD will use the altitude of the highest layer boundary rather than the sensor elevation. To use a high altitude sensor, it is necessary to use a higher layer boundary for the calculation of atmospheric transmittance τ and path radiance Np .

D. DISCUSSION OF THE DATA AND CONCLUSIONS

Based on a sample scenario selected from the data base of the EOMET95 measurement series in Monterey Bay off Moss Landing, ship skin temperature samples measured with a set of transistors were used with historical thermal distributions of the R/V POINT SUR, as measured radiometrically, to estimate an average ship temperature for the selected measurement time. From this together with the sea background temperature computed by SEARAD, a "zero range" contrast temperature difference ΔT was computed as 289.987 - 286.600 = 3.3871. This ΔT has been applied in two ways to estimate the Maximum Detection Range for the R/V POINT SUR. The first and simpler method is to assume that the contrast temperature difference, ΔT, is attenuated by the atmosphere in the same fashion as the radiance, ie $\Delta T_{app} = \Delta T_o e^{-\mu R}$. The second , more justifiable, method is to convert the temperature difference into in-band background radiance and target radiance, compute the corrections for attenuation and path radiance

using SEARAD, and reconvert to an apparent ΔT as a function of range. For each method ΔT_{app} is then compared with the MRTD or MDTD of the assumed sensor, as appropriate, also expressed as a function of range. The point of intersection then gives the maximum detection or recognition range. A weakness of this method is that the ship radiance is based solely on the thermal emission from the ship while the background calculation takes into account the reflected radiance also. The following observations are drawn from the results.

We see in Table 9 (page 53) and Figure 9 that the apparent temperature difference at short range initially increases. At 0.345 km ΔT_{app} is 21.18, much higher than the zero range value of 3.387. After reaching a peak value, the apparent temperature difference then decreases in an approximately exponential fashion with range.

For sensor altitude of 6 meters, beyond elevation angle 0.044, corresponding to a range of 13.262 km the calculated refracted path no longer intersects the earth surface. The path radiance cannot then be calculated, and the MDR cannot be calculated. This geometry is not appropriate for estimation of maximum detection range. The recalculation with assumed higher elevation for the sensor, required a redescription of the atmospheric layer structure, and allows calculation of the path radiance and surface radiance. We see in Table 10, with a sensor altitude of 250 m, ΔT_{app} has a value of 0.007 degrees at range 33.415 km, with zenith angle 0.550 degrees. The variation of ΔT_{app} with range (Figure 10) shows small differences from Figure 9. This must be ascribed to the reassignment of layer structure in SEARAD. The initial increase of ΔT_{app} at short range persists, and the curve is basically similar to Figure 9, except that it is extended to much longer ranges, so that estimation of MDR is possible. A comparison of the ΔT_{app} (R) as computed by the two methods is shown as Table 7.

A direct comparison of these range predictions indicates that the simple Beer's Law variation of ΔT_{app} (R) leads to an underestimation of the maximum range, relative to the SEARAD method including computed transmittance and path radiance. The values shown in Table 7 are comparable to values obtained in other range models. However a

factor of approximately 2 is apparent between the sets of results for detection with smaller differences for classification or identification. This point requires further discussion. The selection of the MDTD or MRTD criterion for detection appears to be of much lesser importance than the other differences between the model approaches.

	Detection Range	Classification Range	Identification Range
I. Extinction only	MRTD: 21 km MDTD: 19 km	MRTD: 8.8 km	MRTD:6.2 km
II. SEARAD Correction	MRTD: 47 km MDTD: 44 km	MRTD: 13 km	MRTD:8 km

Table. 7 Comparison of Two Methods

Some insight into the discrepancy may be gained by comparison of the transmittances calculated with the Beer's Law approach and the SEARAD code. Figure 15 shows this direct comparison. It can be seen that the Beer's Law method considerably underestimates the transmittance compared with direct computation. This is probably due to the band averaging over the 8 to 12 band, for which the apparent extinction coefficient decreases initially approaching a constant value only at longer ranges. The coefficient used in this analysis was deduced from extinction at 1.4 km, a measurement point in the EOMET95 data set. The differences observed in Figure 15 will decrease the discrepancy in predicted range but only in a minor way, as can be seen from the plot of apparent temperature difference shown as Figure 16. The SEARAD method shows negative values at very short range rising to values of up to 20°C, giving an increased effective ΔT_o, before decreasing in an approximately exponential fashion. The greatest factor in the range difference is this high ΔT_o. The SEARAD and Beer's Law methods use the same input radiometric sea surface temperature and thermometric target temperature. The SEARAD code then computes the sea surface radiance taking into account the sea surface

roughness and emissivity, and the reflection of sky radiance. The corresponding radiance temperature is then computed and used in the initial temperature ΔT_o. This procedure leads to the initial negative temperature difference seen in Tables 9 and 10, and in Figure 16. No equivalent radiance temperature model is available for the ship target.

The increase in ΔT_{app} at short ranges is an unexpected feature. Examination of Tables 9 and 10 shows that the ship radiance corrected for path radiance and transmittance decreases slowly and monotonically with range. The background radiance, however, decreases from a large initial value to a minimum occurring at 92° zenith angle for the 6 meter sensor and 95° for the 250 meter sensor, and then rises slowly at longer range. This behavior is not completely understood. It is non-intuitive that the sea radiance and the target radiance should behave differently at long range. The initial behavior at short range may be related to the variation of the emissivity and sky radiance. This behavior deserves further study.

It may be concluded that the use of SEARAD for range prediction constitutes a considerable improvement over the Beer's Law method. However a valid target signature radiance model is needed to give confidence in the predicted range. The SHIPSIG and THERMAL CONTRAST MODEL have been used in some previous prediction models, but are very specific to target and conditions, and so not convenient for general application. Addition of a simple facet ship signature representation to the ship orientation model is recommended.

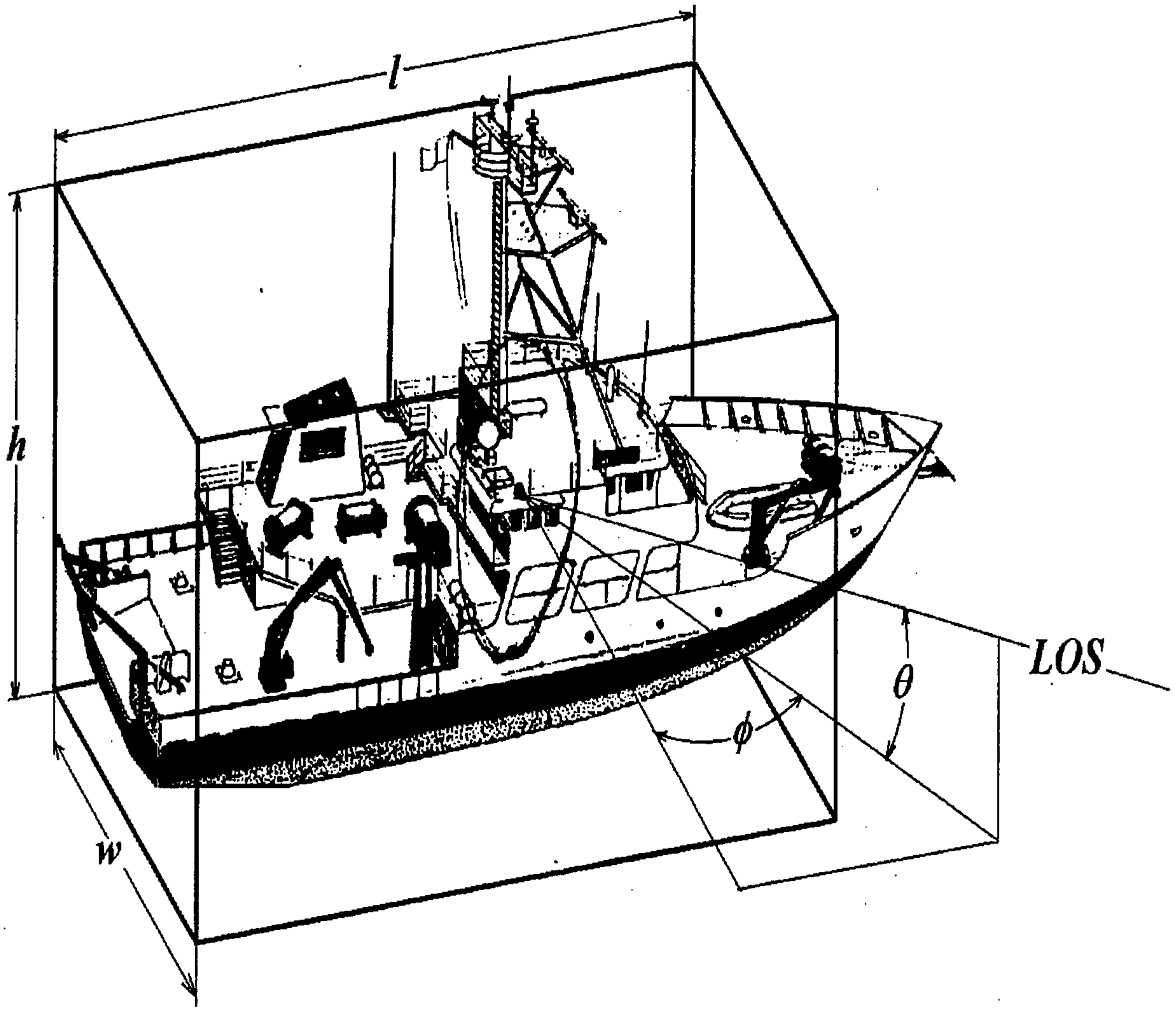
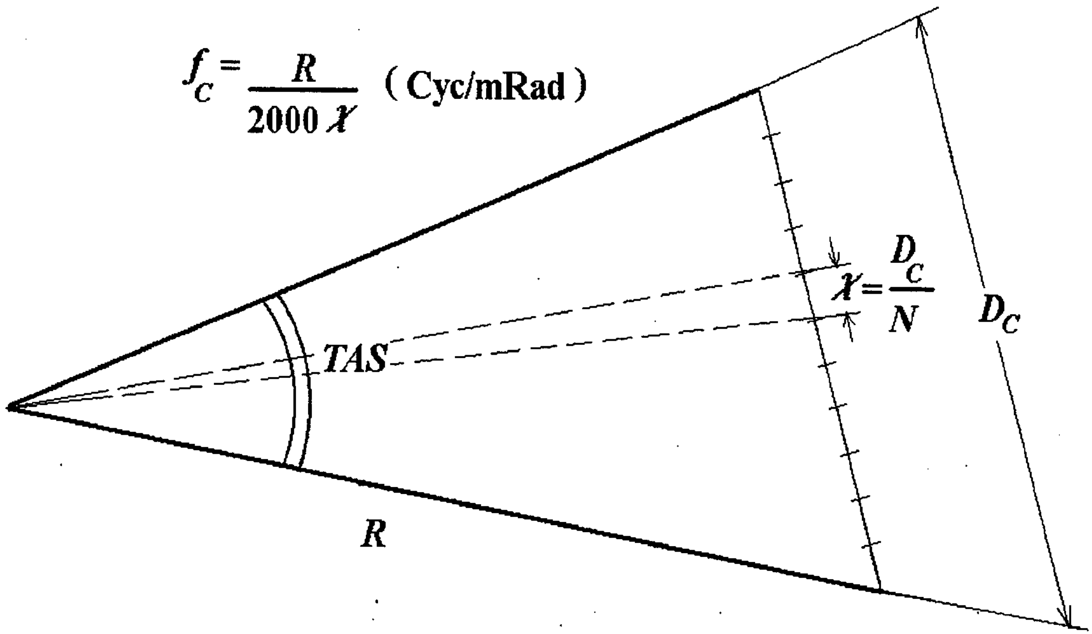
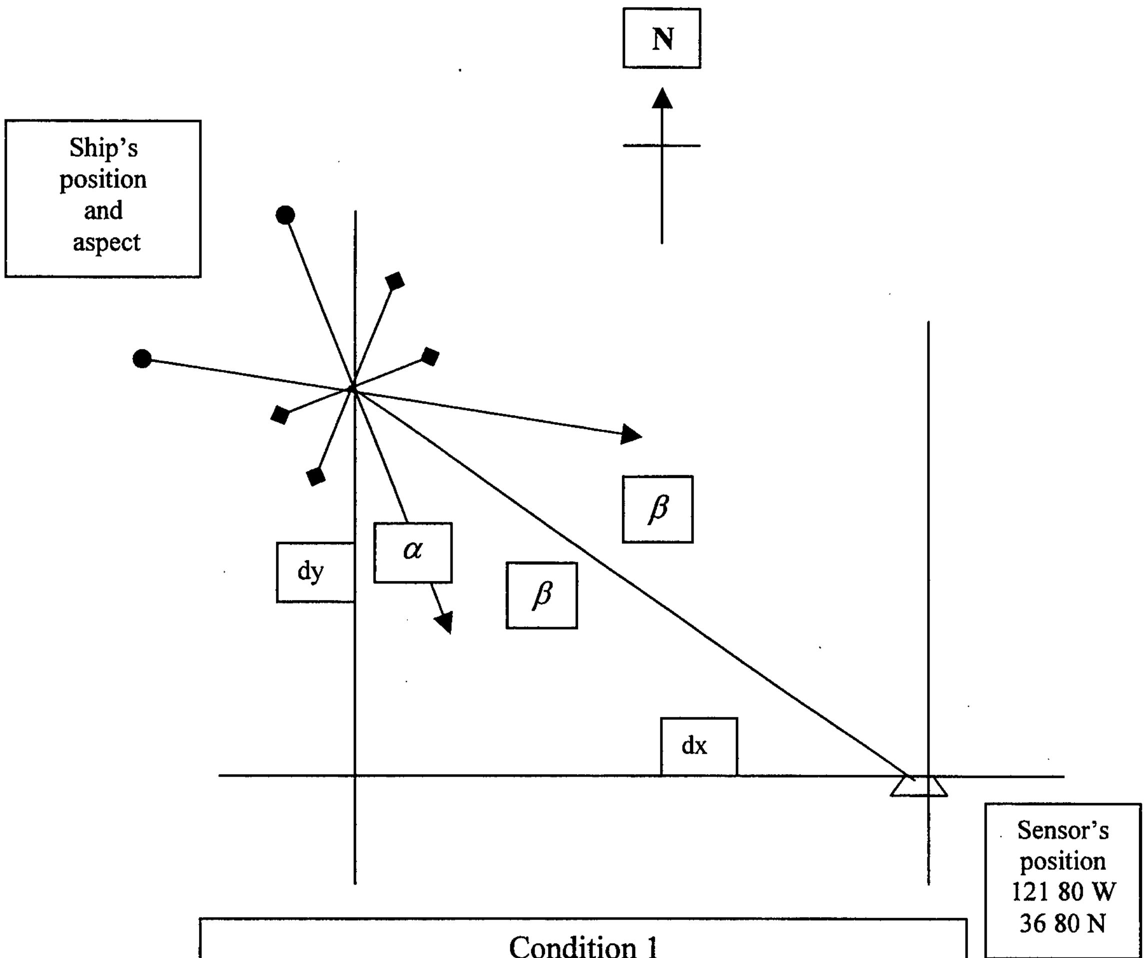


Figure 1. Orientation of Ship Target Model



N = **Number of Bars in the Bar Chart**
R = **Slant Range**
TAS = **Target Angular Subtense**
D_C = **Critical Dimension**
χ = **Physical Dimension to be Resolved**
f_c = **Spatial Frequency of Bar**

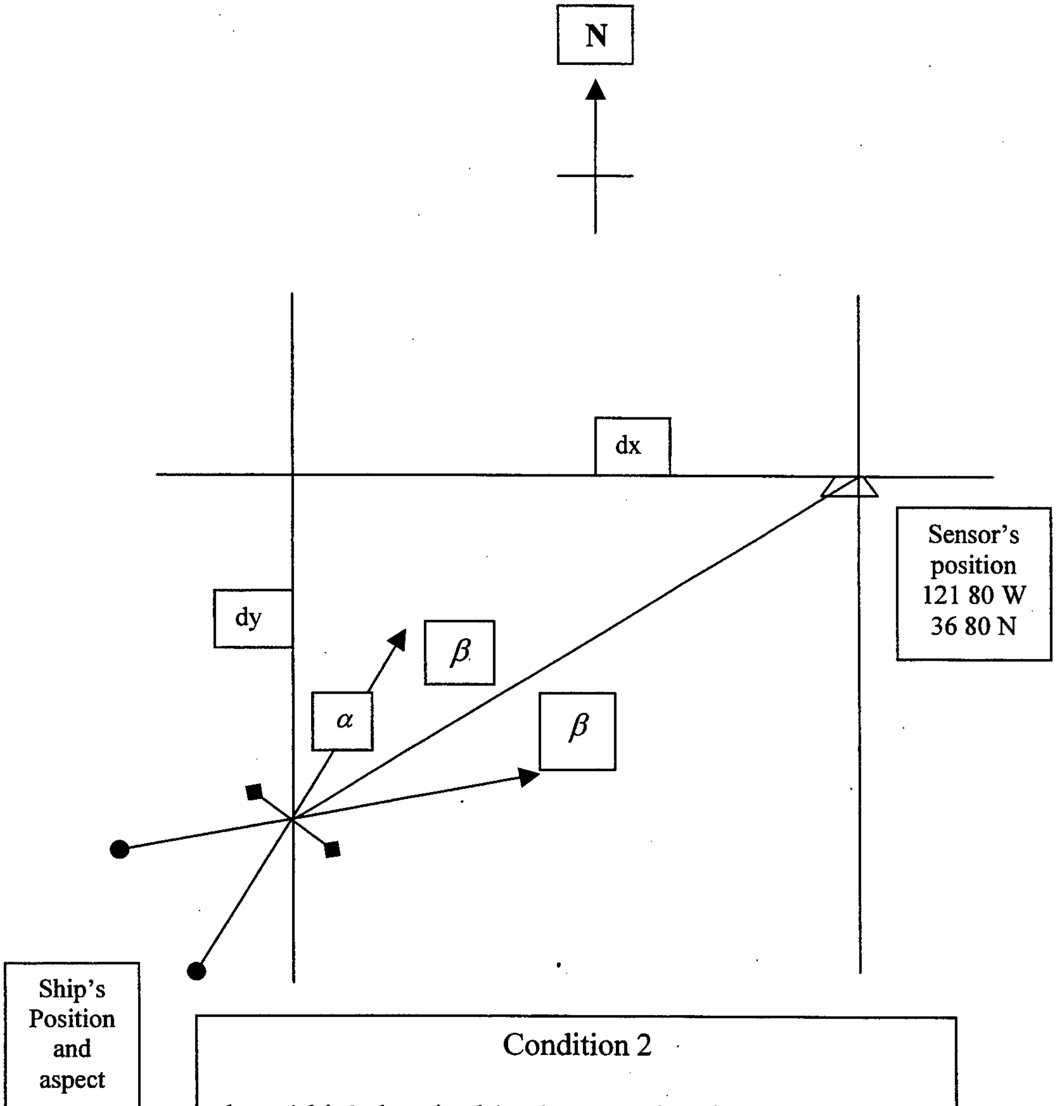
Figure 2. Relation Between Spatial Frequency, Range R and Physical Dimension χ



Condition 1

dx = (ship's longitude) - (sensor's longitude)
dy = (ship's latitude) - (sensor's latitude)
α = arctan (dx/dy)
ϕ = (90 - β)
θ = arctan (6 / Range)
1 degree latitude at 37 degree N latitude is 59.97 nmi
1 degree longitude at 37 degree N latitude is 47.995 nmi
1 nmi = 1.852 km =1852 m

Figure 3. Relation Between GPS and Ship Aspect Condition 1



Condition 2

dx = (ship's longitude) - (sensor's longitude)
dy = (ship's latitude) - (sensor's latitude)
$\alpha = \arctan(dx/dy)$
$\phi = (90 - \beta)$
$\theta = \arctan(6 / \text{Range})$
1 degree latitude at 37 degree N latitude is 59.97 nmi
1 degree longitude at 37 degree N latitude is 47.995 nmi
1 nmi = 1.852 km =1852 m

Figure 4. Relation Between GPS and Ship Aspect Condition 2

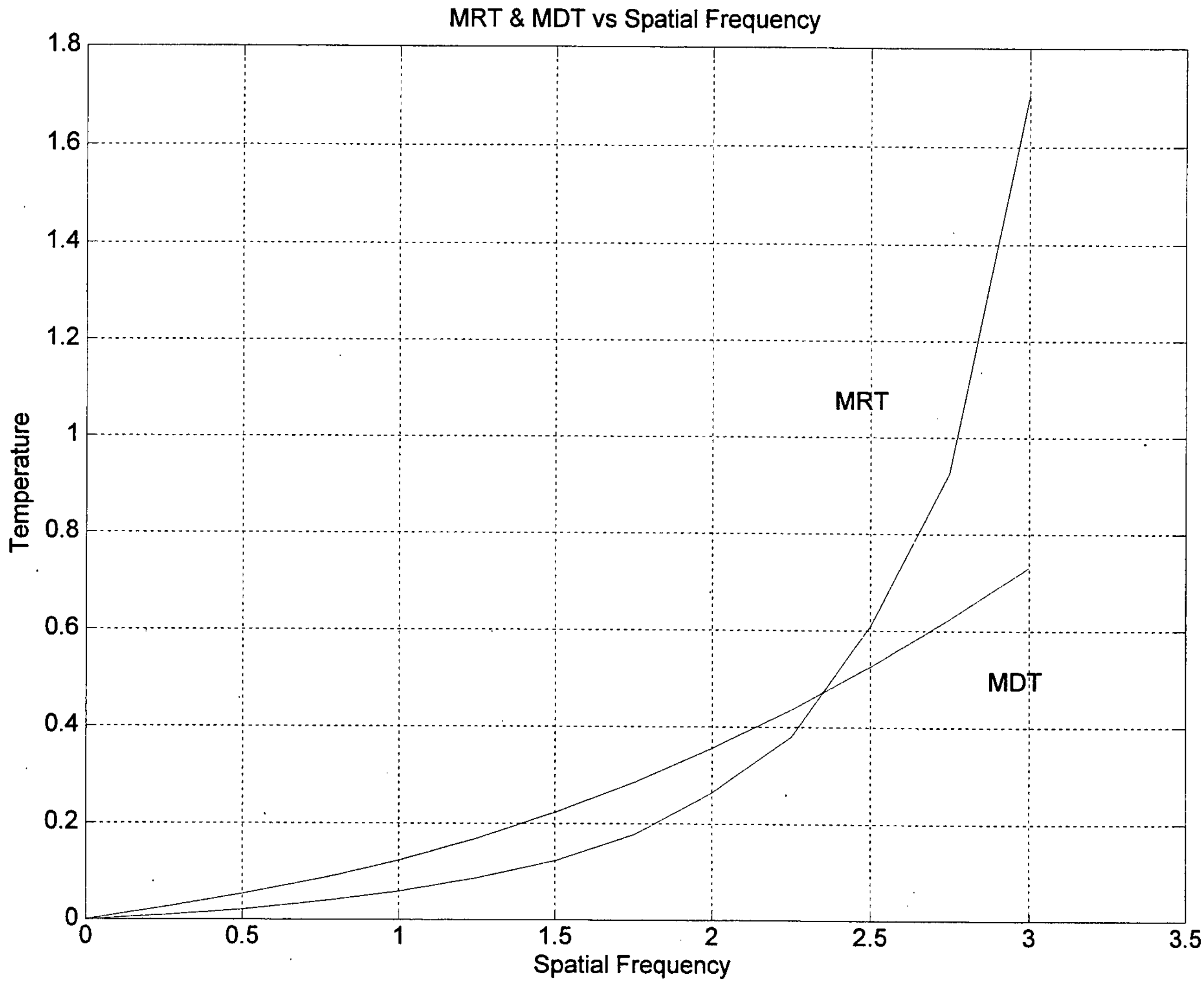


Figure 5. MRTD and MDTD as a Function of Spatial Frequency

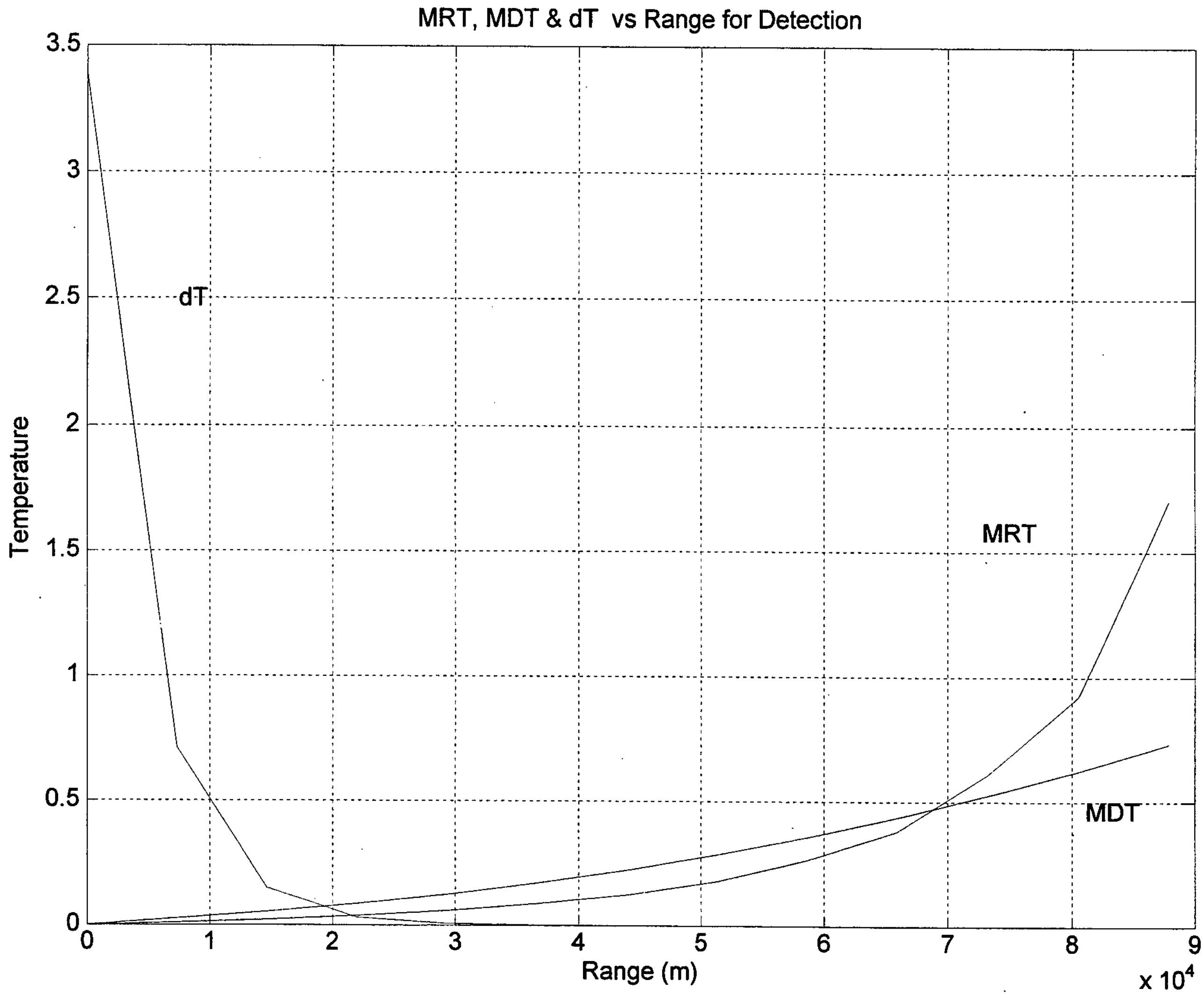


Figure 6. MRTD, MDTD and ΔT as a Function of Range for Detection

of R/V POINT SUR, ΔT by Beer's Law

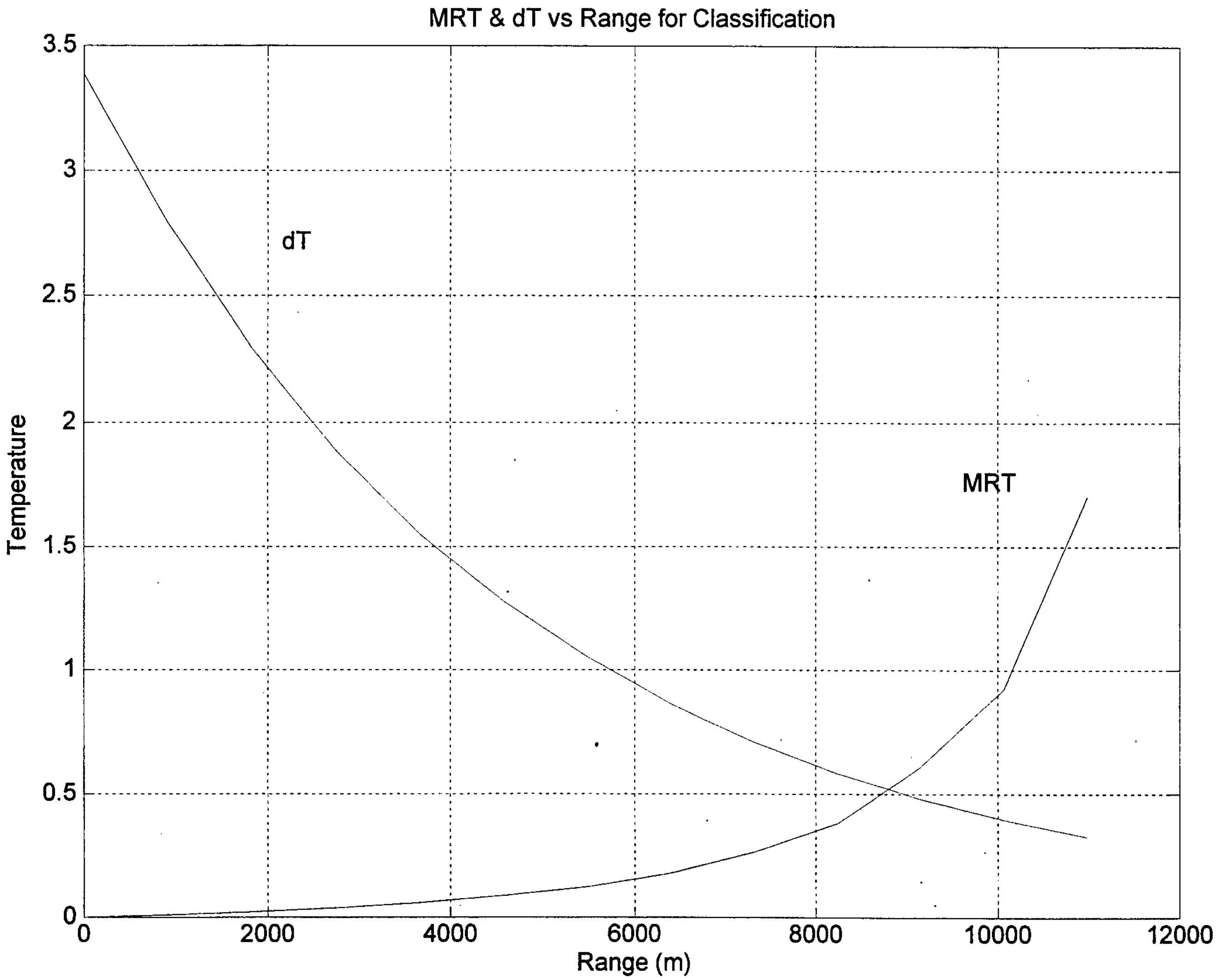


Figure 7. MRTD and ΔT as a Function of Range for Classification;

ΔT by Attenuation of ΔT_0

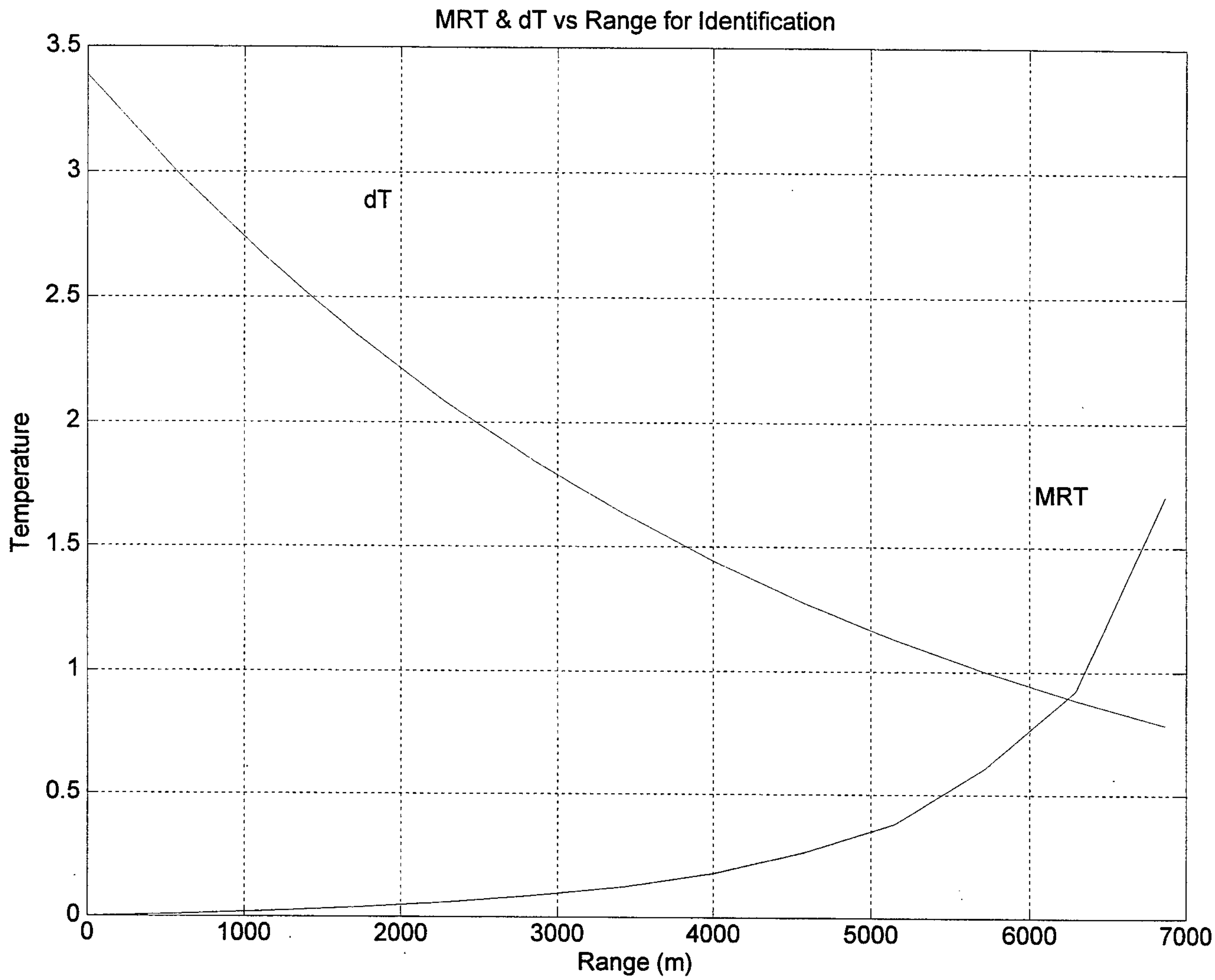


Figure 8. MRTD and ΔT as a Function of Range for Identification:

ΔT by Attenuation of Source Method

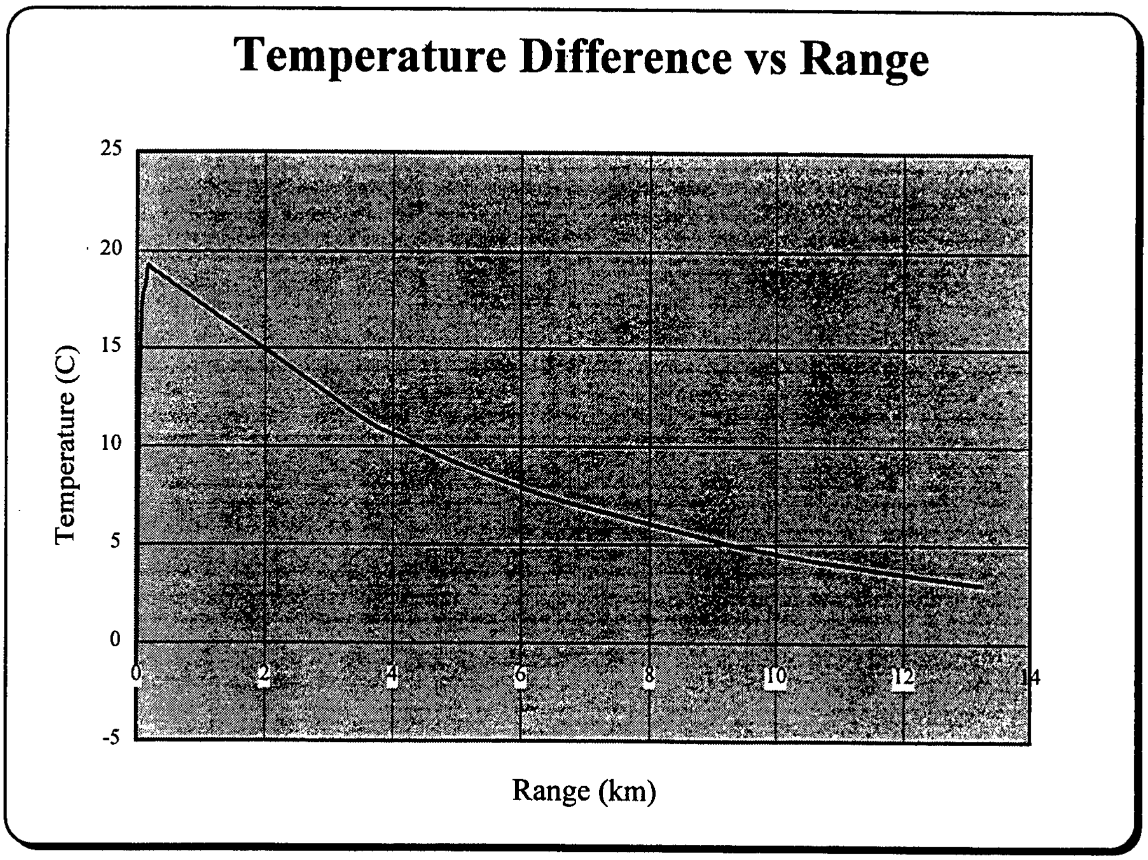


Figure 9. ΔT vs Range for Typical case, by Radiance Compensation Method, (SEARAD) Sensor at 6 meters Elevation

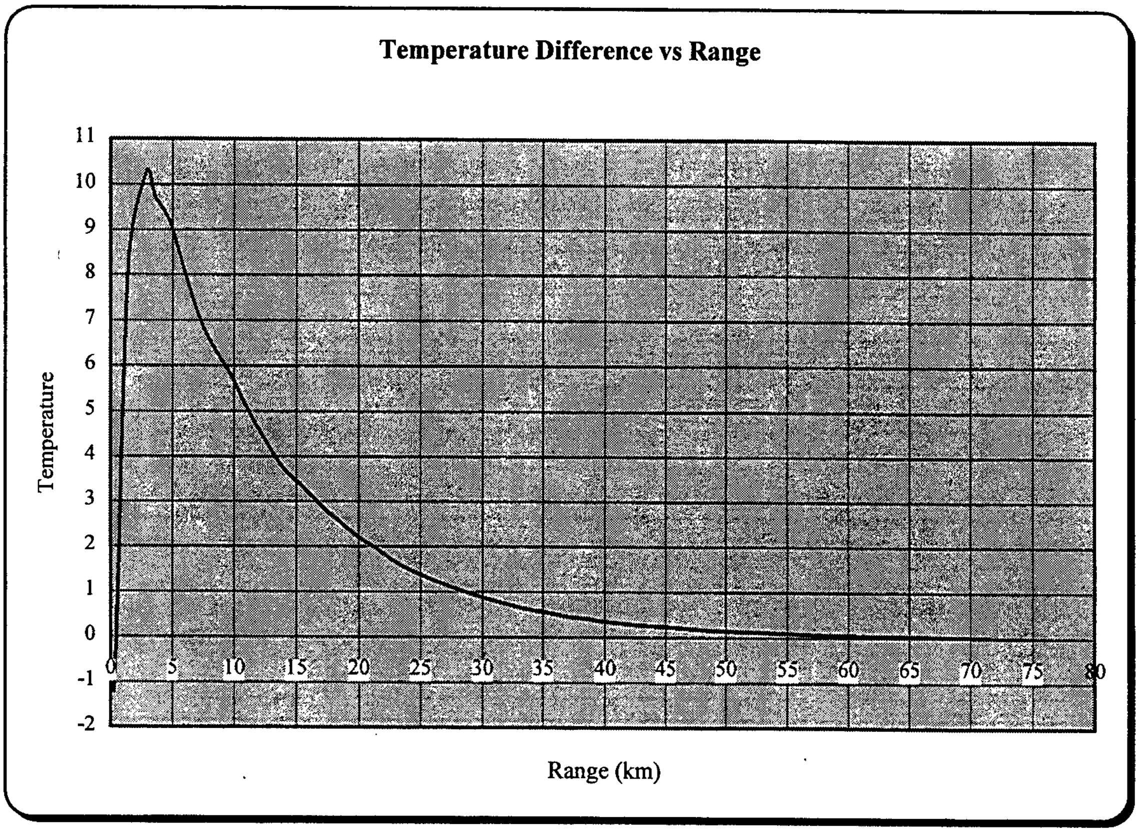


Figure 10. ΔT vs Range for MDR Estimate;

Sensor at 250 meters Elevation

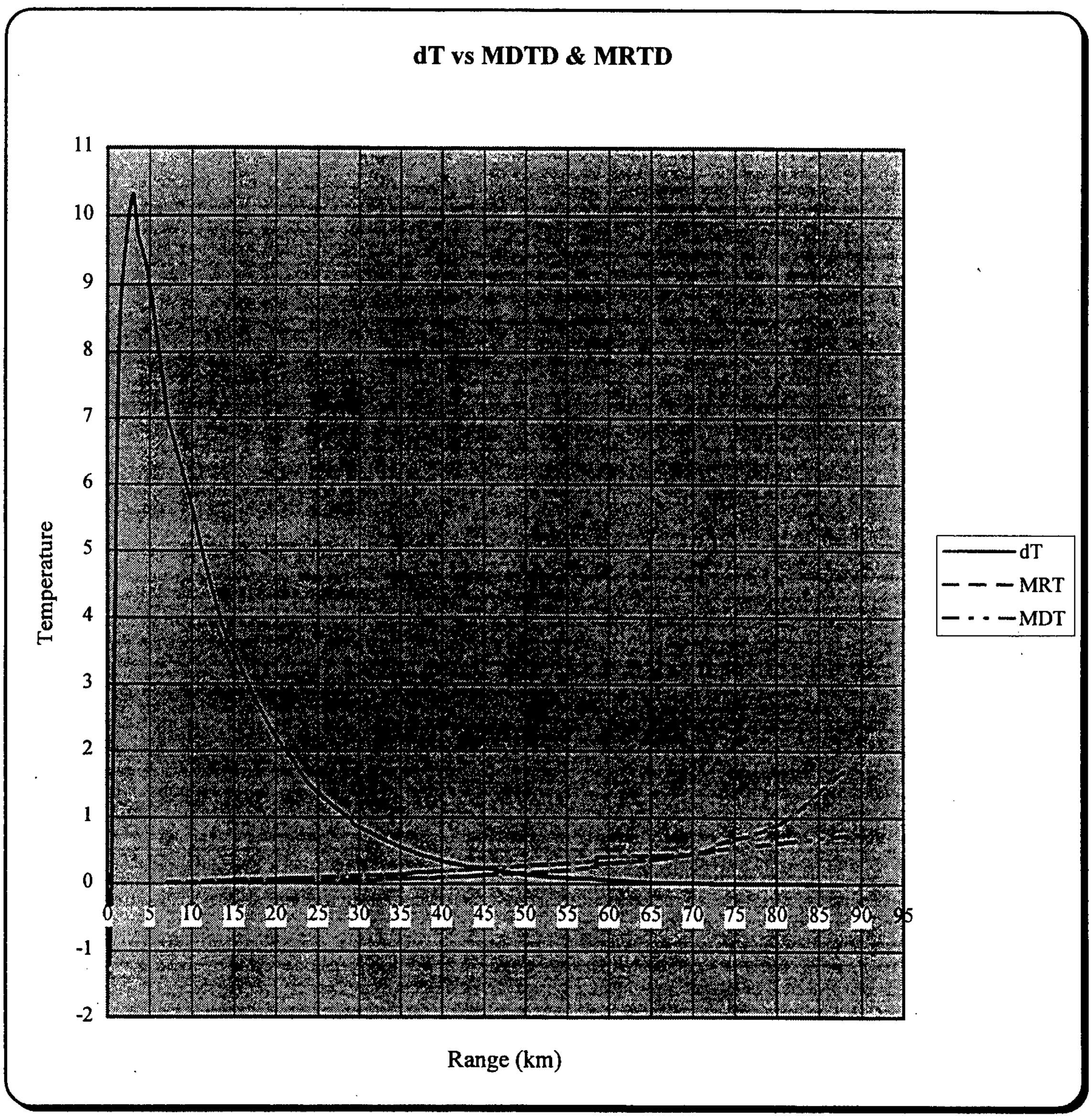


Figure 11. ΔT vs MRTD & MDTD for MDR Estimate

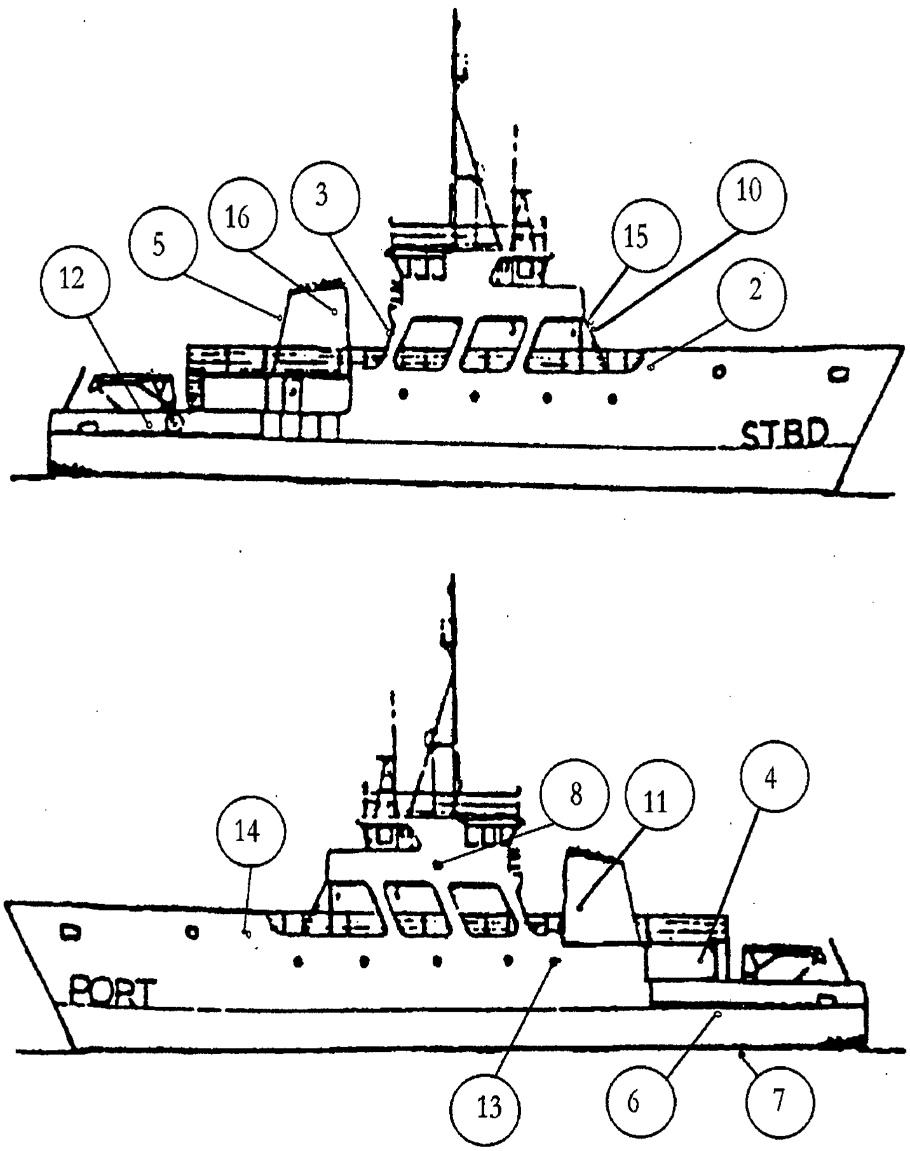
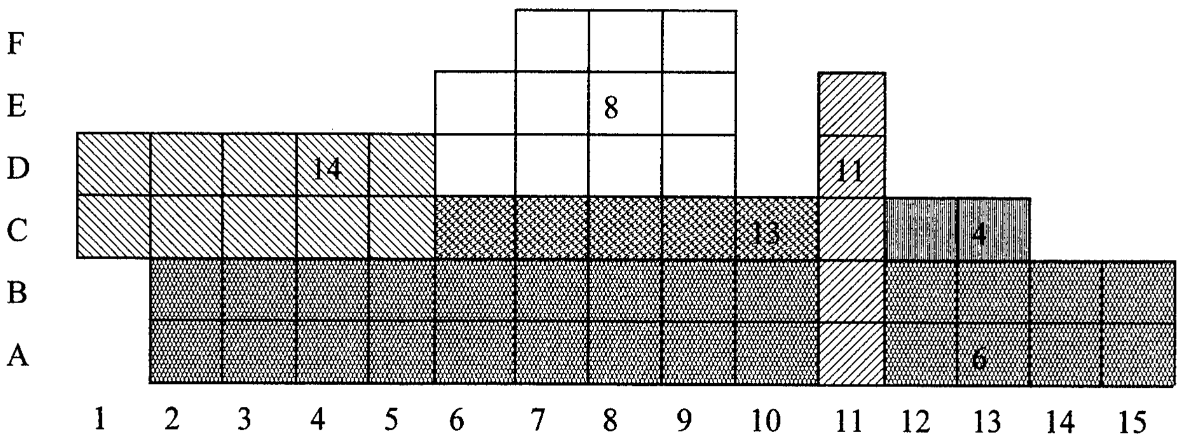


Figure 12. Locations of Thermistors

TEMPERATURE DISTRIBUTION TABLE, R/V POINT SUR PORT BEAM



TEMPERATURE DISTRIBUTION, R/V POINT SUR STARBOARD BEAM

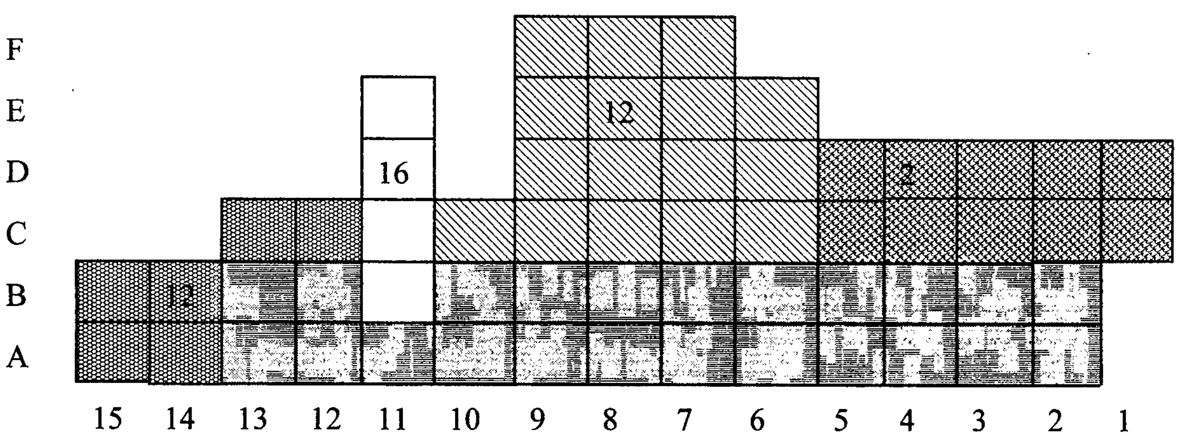


Figure 13. Distribution of Thermistors, and Correlation with Pixels

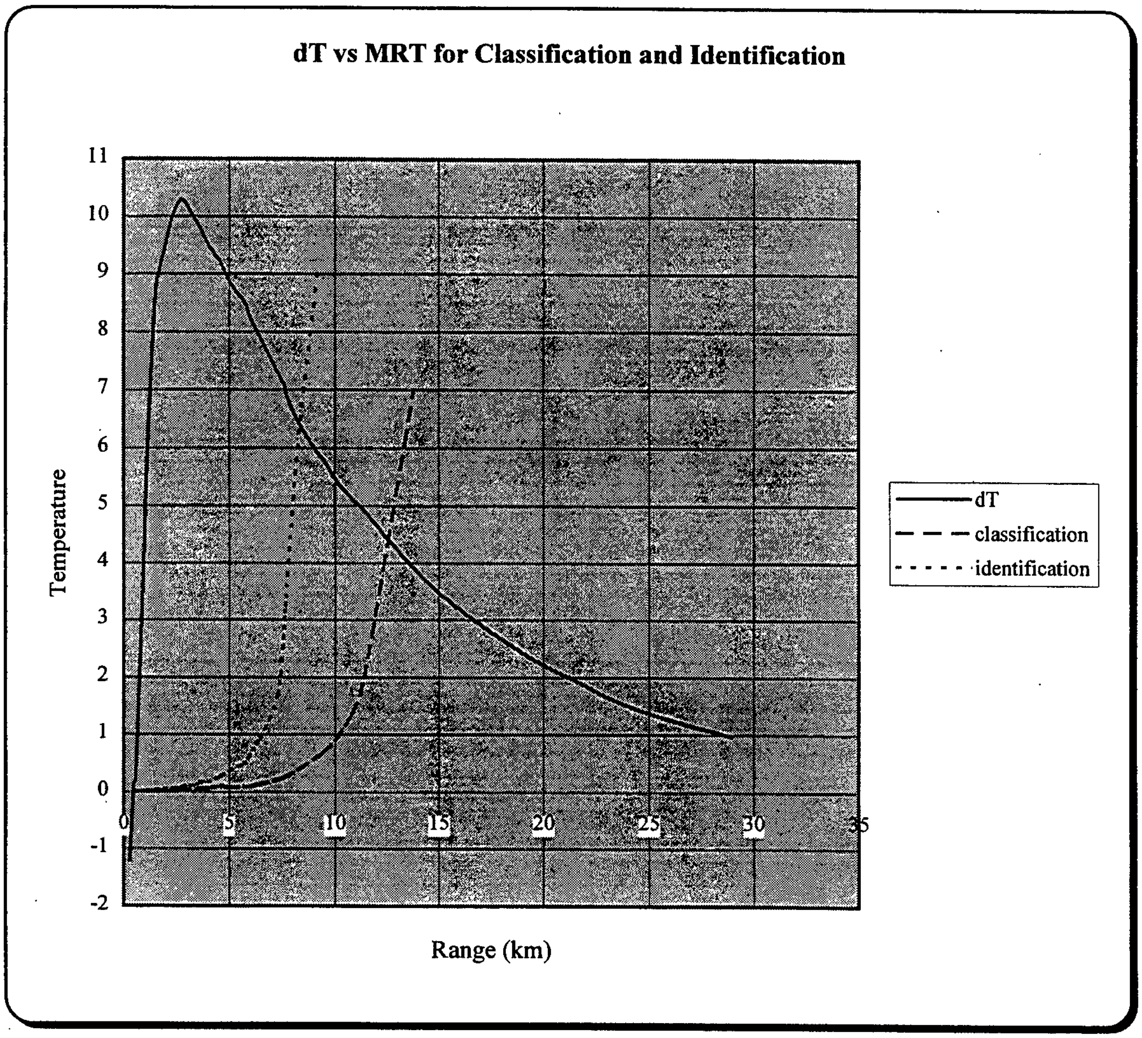


Figure 14. ΔT vs MRTD for Classification and Identification

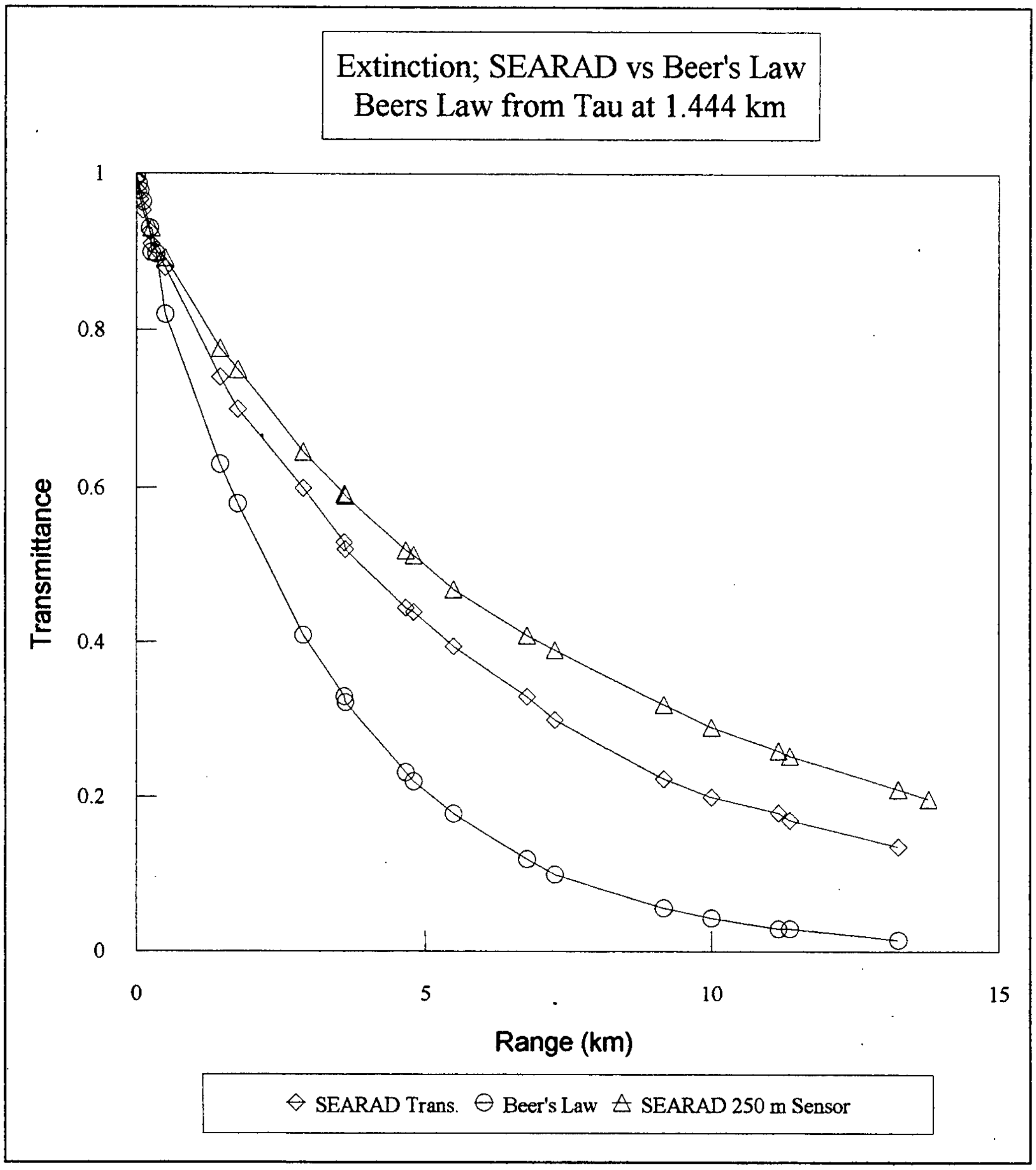


Figure 15. Comparison of Extinction; SEARAD vs Beer's Law

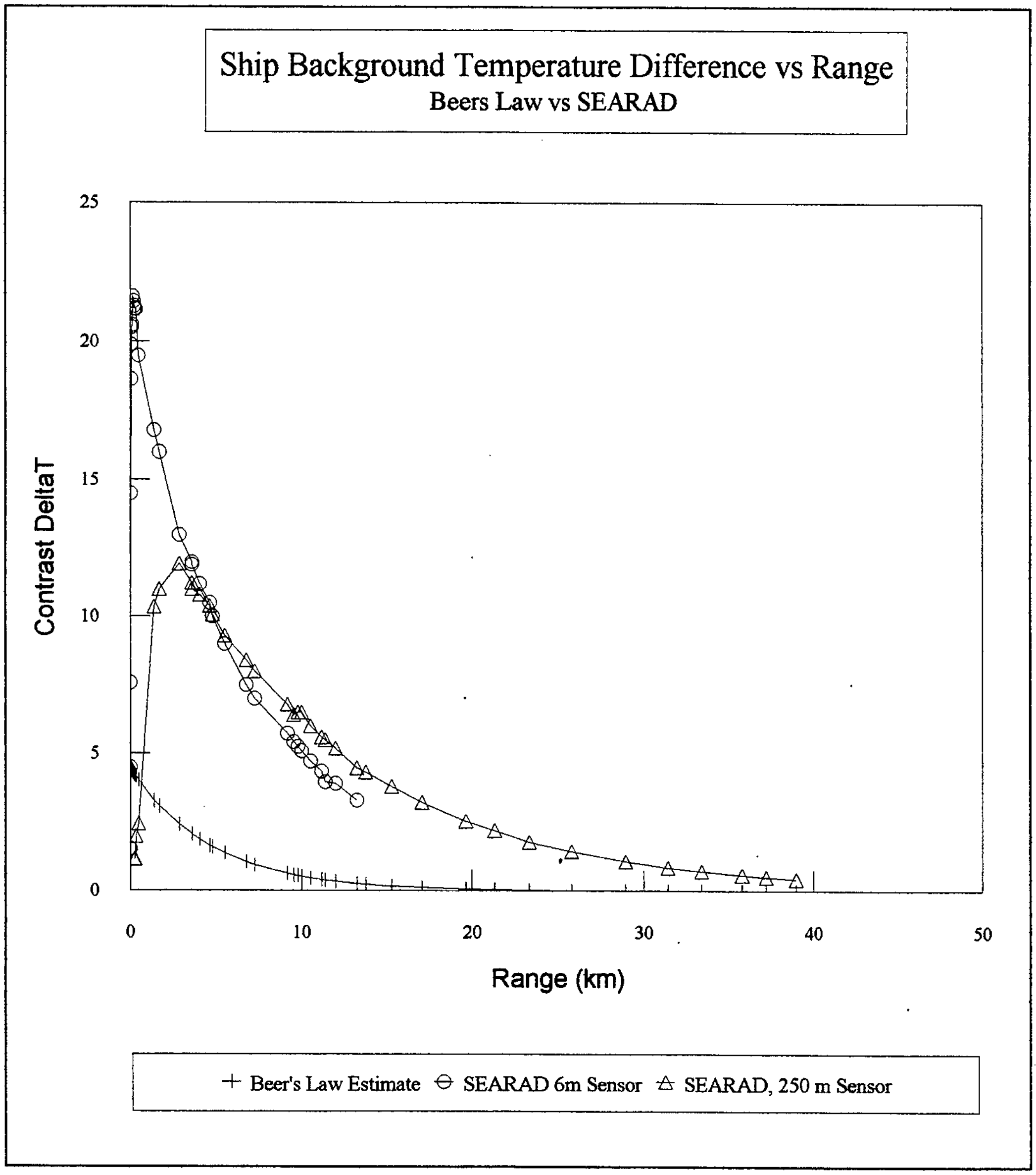


Figure 16. ΔT for Beer's Law vs SEARAD

Date	95/05/16
Time (GMT)	18:37:53
Time (local)	11:37:53
Ship Heading	120
Wind Speed (knot)	3.69
Wind Speed (m/s)	1.8966
Wind Speed (knot) 24-H Average	3.1201
Wind Speed (m/s) 24-H Average	1.6037
Wind Direction	252
Air Temperature (°C)	12.30
Relative Humility (%)	93.34
Pressure (mb)	1012
Latitude	36.81 N
Longitude	121.81 W
Ship Temperature (°C)	16.987144
Ship Temperature (°K)	289.987144
Sea Temperature (°C)	13.60
Sea Temperature (°K)	286.60
Ship Radiance Ns (zero range)	30.14347844
Transmittance τ	0.735
Path Radiance Np	7.58028
$Ns \times \tau + Np = N_{s+p}$	29.7357366
$N_{s+p} \Rightarrow T_{s+p}$	284.68
Background Radiance N_b	21.93238
$N_b \Rightarrow T_b$	268.7
$T_{s+p} - T_b = \Delta T_{app}$	15.98
Observe Range(km) horizontal	1.4225
Observe Range (km)	1.444
ΔT	3.387144
Bearing (degree)	21.326
Azimuth angle (degree)	68.674
Elevation (degree)	0.24066
Ship Project Area (m^2)	214.4513

Table 8. Data File for Typical Case

Observed Range (km)	Zero Range	0.006	0.021	0.039	0.069
Zenith Angle	0.0	158.500	107.000	99.000	95.000
Emissivity ε	******	0.9876	0.8518	0.6937	0.5887
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.0	0.9924	0.9846	0.9773	0.9670
Path Radiance Np	******	0.19415	0.39946	0.59549	0.87565
$Ns \times \tau + Np = N_{S+P}$	******	30.10853	30.07872	30.05470	30.02438
N_{S+P} convert to Temperature	******	285.37	285.32	285.27	285.22
Background Radiance	******	30.63620	27.41545	23.96328	22.04542
N_b convert to Temperature T_b	******	286.35	280.25	273.25	269.05
$T_{S+P} - T_b = \Delta T$	3.387144	- 0.98	5.07	12.02	16.17

Table 9.1 Data File for Typical Case Radiance Computation

Observed Range (km)	0.086	0.115	0.138	0.172	0.230
Zenith Angle	94.000	93.000	92.500	92.000	91.500
Emissivity ε	0.5613	0.5351	0.5227	0.5099	0.4954
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.9618	0.9538	0.9478	0.9393	0.9262
Path Radiance Np	1.01743	1.23811	1.40434	1.64105	2.01083
$Ns \times \tau + Np = N_{S+P}$	30.00941	29.9889	29.97432	29.95481	29.92926
N_{S+P} convert to Temperature	285.19	285.15	285.13	285.09	285.04
Background Radiance	21.46527	21.19206	21.14012	20.68977	20.70253
N_b convert to Temperature T_b	267.75	267.05	266.95	265.85	265.95
$T_{S+P} - T_b = \Delta T$	17.44	18.1	18.18	19.24	19.09

Table 9.2 Data File for Typical Case Radiance Computation

Observed Range (km)	0.345	1.740	3.616	4.071	4.669
Zenith Angle	90.999	90.200	90.100	90.090	90.080
Emissivity ε	0.4820	0.4630	0.4617	0.4616	0.4615
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.9023	0.6995	0.5210	0.4868	0.4457
Path Radiance Np	2.69034	8.63780	13.99925	15.03495	16.27719
Ship Radiance N_{S+P}	29.88879	29.72315	29.70399	29.70879	29.71213
N_{S+P} convert to Temperature T_{S+P}	284.96	284.66	284.62	284.63	284.64
Background Radiance N_b	20.78745	22.26335	24.05040	24.40729	24.83836
N_b convert to Temperature T_b	266.09	269.40	273.4	274.1	275.03
$T_{S+P} - T_b = \Delta T$	18.87	15.57	11.22	10.53	9.61

Table 9.3 Data File for Typical Case Radiance Computation

Observed Range (km)	5.501	6.772	9.167	9.557	10.008
Zenith Angle	90.070	90.060	90.050	90.049	90.048
Emissivity ε	0.4614	0.4613	0.4611	0.4611	0.4611
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.3951	0.3298	0.2366	0.2243	0.2110
Path Radiance Np	17.80972	19.78584	22.60054	22.97070	23.37262
Ship Radiance N_{S+P}	29.71940	29.72715	29.73248	29.73188	29.73289
N_{S+P} convert to Temperature T_{S+P}	284.65	284.67	284.68	284.67	284.68
Background Radiance N_b	25.37396	26.06976	27.06865	27.20058	27.34404
N_b convert to Temperature T_b	276.15	277.57	279.56	279.83	280.11
$T_{S+P} - T_b = \Delta T$	8.5	7.1	5.12	4.84	4.57

Table 9.4 Data File for Typical Case Radiance Computation

Observed Range (km)	10.534	11.174	12.009	13.262	97.261
Zenith Angle	90.047	90.046	90.045	90.044	90.043
Emissivity ε	0.4611	0.4610	0.4610	0.4610	******
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.1965	0.1802	0.1611	0.1363	0.0001
Path Radiance Np	23.80918	24.29645	24.86820	25.60797	******
Ship Radiance N_{S+P}	29.73237	29.72830	29.72431	29.71652	******
N_{S+P} convert to Temperature T_{S+P}	284.66	284.67	284.66	284.65	******
Background Radiance N_b	27.50002	27.67432	27.87898	28.14412	******
N_b convert to Temperature T_b	280.43	280.75	281.15	281.67	******
$T_{S+P} - T_b = \Delta T$	4.23	3.92	3.51	2.98	******

Table 9.5 Data File for Typical Case Radiance Computation

Observe Range (km)	0.259	0.289	0.500	1.441	2.875
Zenith Angle	195.000	150.000	120.000	100.000	95.000
Emissivity ε	0.9877	0.9869	0.9539	0.7180	0.5882
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.9311	0.9258	0.8920	0.7764	0.6457
Path Radiance Np	1.86920	2.018832	2.97817	6.34750	10.23864
$Ns \times \tau + Np = N_{S+P}$	29.93578	29.92565	29.86614	29.75089	29.70227
N_{S+P} convert to Temperature T_{S+P}	285.06	285.04	284.93	284.71	284.62
Background Radiance N_b	30.59705	30.57243	29.77694	25.48528	24.50860
N_b convert to Temperature T_b	286.27	286.23	284.76	276.35	274.35
$T_{S+P} - T_b = \Delta T$	-1.21	-1.19	0.17	8.36	10.27

Table 10.1 Data File for MDR Computation

Observed Range (km)	3.596	4.805	7.260	9.783	11.382
Zenith Angle	94.000	93.000	92.000	91.500	91.300
Emissivity ε	0.5607	0.5344	0.5084	0.4935	0.4882
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.5919	0.5140	0.3909	0.2985	0.2526
Path Radiance Np	11.85932	14.21330	17.95142	20.76567	22.16049
$Ns \times \tau + Np = N_{S+P}$	29.70123	29.70704	29.73450	29.76349	29.77473
N_{S+P} convert to Temperature T_{S+P}	284.62	284.63	284.68	284.73	284.76
Background Radiance N_b	24.55046	25.01152	25.88875	26.76083	27.20808
N_b convert to Temperature T_b	274.9	275.49	277.7	278.95	279.85
$T_{S+P} - T_b = \Delta T$	9.72	9.14	6.98	5.78	4.91

Table 10.2 Data File for MDR Computation

Observed Range (km)	13.776	15.334	17.098	19.663	21.299
Zenith Angle	91.090	90.990	90.900	90.800	90.750
Emissivity ε	0.4818	0.4785	0.4756	0.4725	0.4709
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.1977	0.1690	0.1418	0.1101	0.0939
Path Radiance Np	23.82643	24.69582	25.51815	26.46917	26.95469
$Ns \times \tau + Np = N_{S+P}$	29.78579	29.79006	29.79249	29.78796	29.78516
N_{S+P} convert to Temperature T_{S+P}	284.77	284.78	284.79	284.78	284.78
Background Radiance N_b	27.73904	28.01768	28.28500	28.59857	28.76048
N_b convert to Temperature T_b	280.95	281.4	281.9	282.5	282.8
$T_{S+P} - T_b = \Delta T$	3.82	3.38	2.89	2.28	1.98

Table 10.3 Data File for MDR Computation

Observed Range (km)	23.278	25.743	28.948	31.421	33.415
Zenith Angle	90.700	90.650	90.600	90.570	90.550
Emissivity ε	0.4694	0.4679	0.4664	0.4655	0.4649
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.0776	0.0613	0.0452	0.0358	0.0297
Path Radiance Np	27.44248	27.92743	28.40245	28.67854	28.85722
$Ns \times \tau + Np = N_{S+P}$	29.78161	29.77522	29.76493	29.75767	29.75248
N_{S+P} convert to Temperature T_{S+P}	284.77	284.76	284.74	284.72	284.71
Background Radiance N_b	28.92441	29.08870	29.25099	29.34601	29.40779
N_b convert to Temperature T_b	283.16	283.47	283.77	283.95	284.07
$T_{S+P} - T_b = \Delta T$	1.61	1.29	0.97	0.77	0.64

Table 10.4 Data File for MDR Computation

Observed Range (km)	35.809	37.210	38.962	39.310	42.769
Zenith Angle	90.530	90.520	90.509	90.507	90.490
Emissivity ε	0.4643	0.4640	0.4637	0.4636	0.4630
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.0237	0.0208	0.0177	0.0171	0.0124
Path Radiance Np	29.03059	29.11495	29.20565	29.22193	29.35741
$Ns\times\tau+Np = N_{S+P}$	29.74499	29.74193	29.73918	29.73738	29.73118
N_{S+P} convert to Temperature T_{S+P}	284.70	284.69	284.69	284.68	284.67
Background Radiance N_b	29.46800	29.49740	29.52908	29.53478	29.58232
N_b convert to Temperature T_b	284.18	284.24	284.30	284.31	284.40
$T_{S+P}-T_b=\Delta T$	0.52	0.45	0.39	0.37	0.27

Table 10.5 Data File for MDR Computation

Observed Range (km)	45.409	48.877	54.146	58.641	71.559
Zenith Angle	90.480	90.470	90.460	90.455	90.450
Emissivity ε	0.4626	0.4623	0.4618	0.4615	0.4610
Ship Radiance Ns	30.14347	30.14347	30.14347	30.14347	30.14347
Transmittance τ	0.0097	0.0070	0.0043	0.0028	0.0008
Path Radiance Np	29.43472	29.51111	29.58875	29.63071	29.68708
$Ns \times \tau + Np = N_{S+P}$	29.72711	29.72211	29.71836	29.71511	29.71111
N_{S+P} convert to Temperature T_{S+P}	284.67	284.66	284.65	284.64	284.63
Background Radiance N_b	29.60958	29.63663	29.66433	29.67943	29.69996
N_b convert to Temperature T_b	284.44	284.50	284.55	284.58	284.62
$T_{S+P} - T_b = \Delta T$	0.23	0.16	0.10	0.06	0.01

Table 10.6 Data File for MDR Computation

Channel	Location	Temperature	Pixel	Temp×Pixel
1	Reference	25.001	****	*****
2	Starboard bow	16.423	10	164.23
3	Aft pilot house	17.864	****	****
4	Port aft of stack	17.291	2	34.582
5	Aft on stack	15.361	****	****
6	Aft port	15.830	26	411.58
7	Aft port water	14.368	****	****
8	Port pilot house	15.909	11	174.999
9	Reference	25.001	****	****
10	Bow pilot house	18.333	****	****
11	Port stack	24.164	5	120.82
12	Aft starboard	15.296	22	336.512
13	Port below stack	16.151	5	80.755
14	Port bow	15.346	10	153.46
15	Bow air	22.393	****	****
16	Starboard stack	28.829	4	115.316
**	Starboard above water-line	17.923	23	412.229
Total	*********	*****	118	2004.483

Table 11. Distribution and Location of Thermistors

APPENDIX A. THERMISTOR SAMPLE OUTPUT FILE

May 16.1

Mon,Day,Year = 5 16 1995

Hour,Min,Sec = 8 27 36

volts,istart,istop,nsam,iref 1.49939 1 16 100 1

1326456 25.001 12.856 13.403 11.963 14.615 11.677 12.359 11.634 25.001 14.242
22.956 12.010 11.617 11.431 15.410 25.874

1326476 25.001 12.864 13.397 11.959 14.646 11.673 12.371 11.633 25.001 14.200
22.937 12.001 11.607 11.426 15.229 25.535

1326496 25.001 12.858 13.394 11.954 14.699 11.662 12.415 11.647 25.001 14.162
22.924 11.993 11.598 11.420 15.138 25.186

1326516 25.001 12.861 13.404 11.950 14.752 11.662 12.437 11.625 25.001 14.145
22.923 11.989 11.593 11.416 15.062 24.958

1337856 25.001 16.392 17.862 17.334 15.415 15.885 14.338 15.873 25.001 18.294
24.326 15.281 16.169 15.352 22.299 28.721

**1337876 25.001 16.423 17.864 17.291 15.361 15.830 14.368 15.909 25.001 18.333
24.164 15.296 16.151 15.346 22.393 28.829**

1337896 25.001 16.458 17.844 17.241 15.295 15.771 14.383 15.946 25.001 18.366
24.093 15.304 16.117 15.305 22.319 28.933

1337916 25.001 16.495 17.819 17.200 15.242 15.716 14.404 15.972 25.001 18.395
24.064 15.318 16.083 15.264 22.276 29.048

1337936 25.001 16.528 17.796 17.160 15.188 15.677 14.354 15.997 25.001 18.421
24.021 15.341 16.061 15.248 22.188 29.162

1337956 25.001 16.559 17.799 17.118 15.150 15.638 14.274 15.983 25.001 18.451
23.944 15.370 16.044 15.256 22.322 29.302

APPENDIX B. PROPORTIONAL RADIATION TABLE

The "Proportional Radiation", q=f(λ , T) represents the fraction of the radiant exitance which is emitted by a blackbody at temperature T at all wavelengths up to the selected values of λ. It is obtained from the integral over the Planck Law for wavelengths up to the selected values divided by the integral over all wavelengths, i.e.

$$q = \frac{\int_0^{\lambda} M(\lambda T)d\lambda}{\int_0^{\infty} M(\lambda T)d\lambda}$$

λT/cm K	q	λT/cm K	q	λT/cm K	q
0.050	1.3652E-9	0.140	7.9035E-3	0.460	5.8075E-1
0.052	3.6788E-9	0.150	1.3023E-2	0.480	6.0880E-1
0.054	9.1749E-9	0.160	1.9962E-2	0.500	6.3494E-1
0.056	2.1358E-8	0.170	2.8858E-2	0.520	6.5912E-1
0.058	4.6745E-8	0.180	3.9754E-2	0.540	6.8146E-1
0.060	9.6798E-8	0.190	5.2613E-2	0.560	7.0209E-1
0.062	1.9069E-7	0.200	6.7331E-2	0.580	7.2116E-1
0.064	3.5907E-7	0.210	8.3750E-2	0.600	7.3877E-1
0.066	6.4902E-7	0.220	1.0168E-1	0.620	7.5507E-1
0.068	1.1302E-6	0.230	1.2091E-1	0.660	7.8402E-1
0.070	1.9025E-6	0.240	1.4122E-1	0.700	8.0885E-1
0.072	3.1045E-6	0.250	1.6239E-1	0.740	8.3020E-1
0.074	4.9236E-6	0.260	1.8423E-1	0.780	8.4861E-1
0.076	7.6070E-6	0.270	2.0653E-1	0.820	8.6455E-1
0.078	1.1473E-5	0.280	2.2911E-1	0.860	8.7840E-1
0.080	1.6923E-5	0.290	2.5183E-1	0.900	8.9048E-1
0.082	2.4453E-5	0.300	2.7454E-1	0.940	9.0100E-1
0.084	3.4668E-5	0.310	2.9712E-1	0.980	9.1033E-1
0.086	4.8287E-5	0.320	3.1947E-1	1.00	9.1455E-1
0.088	6.6159E-5	0.330	3.4150E-1	1.10	9.3217E-1
0.090	8.9269E-5	0.340	3.6314E-1	1.20	9.4532E-1

0.092	1.1874E-4	0.350	3.8432E-1	1.30	9.5331E-1
0.094	1.5586E-4	0.360	4.0502E-1	1.40	9.6304E-1
0.096	2.0204E-4	0.370	4.2518E-1	1.50	9.6909E-1
0.098	2.5885E-4	0.380	4.4479E-1	1.60	9.7390E-1
0.100	3.2804E-4	0.390	4.6382E-1	1.70	9.7777E-1
0.110	9.2957E-4	0.400	4.8227E-1	1.80	9.8091E-1
0.120	2.1727E-3	0.420	5.1738E-1	1.90	9.8349E-1
0.130	4.3866E-3	0.440	5.5012E-1	2.00	9.8563E-1

Adapted from "Optoelectronics; Theory and Practice" A. Chappell. Ed., McGraw-Hill Book Company, 1978

APPENDIX C. LOOK-UP TABLE

In-band Radiance (8-12μm)
and Apparent Temperature Conversion Look-up Table

```
% Numerical Integration for Planck's law
% Integration by midpoint rule
% Matlab program with look-up table outputs
clear;
Tmin=291.; % <--- Guess T to obtain the corresponding radiance
dT=0.01;
n=200;

disp(' Temperature      Radiance');
disp(' -----------      --------------');
h=6.626e-34; c=2.998e8; k=1.382e-23;
a=8e-6; b=12e-6; dx=0.001e-6;

 for T=Tmin:dT:Tmin+n*dT

  sf=0.0;

  for x=a:dx:b-dx

   xm=x+dx/2;          % midpoint of f(x)

   f1=(2*h*c^2)/(xm^5);
   f2=1/(exp((h*c)/(xm*k*T))-1);
   fx=f1*f2;
   sf=sf+fx*dx;

  end;

  disp([T,sf]);

end;

end;
```

(Liu, 1996)

Look-up Table for Temperature and Radiance Conversions

Temp	Radiance	Temp	Radiance	Temp	Radiance	Temp	Radiance
-----------	---------	-----------	---------	-----------	---------	-----------	---------
283.0000	28.8410	283.0100	28.8463	283.0200	28.8515	283.0300	28.8568
283.0400	28.8621	283.0500	28.8673	283.0600	28.8726	283.0700	28.8779
283.0800	28.8832	283.0900	28.8884	283.1000	28.8937	283.1100	28.8990
283.1200	28.9042	283.1300	28.9095	283.1400	28.9148	283.1500	28.9201
283.1600	28.9253	283.1700	28.9306	283.1800	28.9359	283.1900	28.9412
283.2000	28.9464	283.2100	28.9517	283.2200	28.9570	283.2300	28.9623
283.2400	28.9676	283.2500	28.9728	283.2600	28.9781	283.2700	28.9834
283.2800	28.9887	283.2900	28.9940	283.3000	28.9993	283.3100	29.0045
283.3200	29.0098	283.3300	29.0151	283.3400	29.0204	283.3500	29.0257
283.3600	29.0310	283.3700	29.0363	283.3800	29.0415	283.3900	29.0468
283.4000	29.0521	283.4100	29.0574	283.4200	29.0627	283.4300	29.0680
283.4400	29.0733	283.4500	29.0786	283.4600	29.0839	283.4700	29.0892
283.4800	29.0945	283.4900	29.0998	283.5000	29.1051	283.5100	29.1104
283.5200	29.1157	283.5300	29.1210	283.5400	29.1263	283.5500	29.1316
283.5600	29.1369	283.5700	29.1422	283.5800	29.1475	283.5900	29.1528
283.6000	29.1581	283.6100	29.1634	283.6200	29.1687	283.6300	29.1740
283.6400	29.1793	283.6500	29.1846	283.6600	29.1899	283.6700	29.1952
283.6800	29.2005	283.6900	29.2058	283.7000	29.2111	283.7100	29.2164
283.7200	29.2217	283.7300	29.2270	283.7400	29.2323	283.7500	29.2377
283.7600	29.2430	283.7700	29.2483	283.7800	29.2536	283.7900	29.2589
283.8000	29.2642	283.8100	29.2695	283.8200	29.2749	283.8300	29.2802
283.8400	29.2855	283.8500	29.2908	283.8600	29.2961	283.8700	29.3014
283.8800	29.3068	283.8900	29.3121	283.9000	29.3174	283.9100	29.3227
283.9200	29.3280	283.9300	29.3334	283.9400	29.3387	283.9500	29.3440
283.9600	29.3493	283.9700	29.3547	283.9800	29.3600	283.9900	29.3653

284.0000	29.3706	284.0100	29.3760	284.0200	29.3813	284.0300	29.3866
284.0400	29.3920	284.0500	29.3973	284.0600	29.4026	284.0700	29.4079
284.0800	29.4133	284.0900	29.4186	284.1000	29.4239	284.1100	29.4293
284.1200	29.4346	284.1300	29.4399	284.1400	29.4453	284.1500	29.4506
284.1600	29.4559	284.1700	29.4613	284.1800	29.4666	284.1900	29.4720
284.2000	29.4773	284.2100	29.4826	284.2200	29.4880	284.2300	29.4933
284.2400	29.4987	284.2500	29.5040	284.2600	29.5093	284.2700	29.5147
284.2800	29.5200	284.2900	29.5254	284.3000	29.5307	284.3100	29.5361
284.3200	29.5414	284.3300	29.5468	284.3400	29.5521	284.3500	29.5574
284.3600	29.5628	284.3700	29.5681	284.3800	29.5735	284.3900	29.5788
284.4000	29.5842	284.4100	29.5895	284.4200	29.5949	284.4300	29.6003
284.4400	29.6056	284.4500	29.6110	284.4600	29.6163	284.4700	29.6217
284.4800	29.6270	284.4900	29.6324	284.5000	29.6377	284.5100	29.6431
284.5200	29.6485	284.5300	29.6538	284.5400	29.6592	284.5500	29.6645
284.5600	29.6699	284.5700	29.6753	284.5800	29.6806	284.5900	29.6860
284.6000	29.6913	284.6100	29.6967	284.6200	29.7021	284.6300	29.7074
284.6400	29.7128	284.6500	29.7182	284.6600	29.7235	284.6700	29.7289
284.6800	29.7343	284.6900	29.7396	284.7000	29.7450	284.7100	29.7504
284.7200	29.7557	284.7300	29.7611	284.7400	29.7665	284.7500	29.7719
284.7600	29.7772	284.7700	29.7826	284.7800	29.7880	284.7900	29.7934
284.8000	29.7987	284.8100	29.8041	284.8200	29.8095	284.8300	29.8149
284.8400	29.8202	284.8500	29.8256	284.8600	29.8310	284.8700	29.8364
284.8800	29.8418	284.8900	29.8471	284.9000	29.8525	284.9100	29.8579
284.9200	29.8633	284.9300	29.8687	284.9400	29.8740	284.9500	29.8794
284.9600	29.8848	284.9700	29.8902	284.9800	29.8956	284.9900	29.9010
285.0000	**29.9064**	285.0100	29.9118	285.0200	29.9171	285.0300	29.9225
285.0400	29.9279	285.0500	29.9333	285.0600	29.9387	285.0700	29.9441
285.0800	**29.9495**	285.0900	29.9549	285.1000	29.9603	285.1100	29.9657

285.1200	29.9711	**285.1300**	**29.9765**	285.1400	29.9819	285.1500	29.9872
285.1600	29.9926	285.1700	29.9980	285.1800	30.0034	**285.1900**	**30.0088**
285.2000	30.0142	285.2100	30.0196	**285.2200**	**30.0250**	285.2300	30.0304
285.2400	30.0358	285.2500	30.0412	**285.2600**	**30.0467**	285.2700	30.0521
285.2800	30.0575	**285.2900**	**30.0629**	285.3000	30.0683	285.3100	30.0737
285.3200	30.0791	285.3300	30.0845	285.3400	30.0899	285.3500	30.0953
285.3600	30.1007	285.3700	30.1061	285.3800	30.1115	285.3900	30.1169
285.4000	30.1224	285.4100	30.1278	285.4200	30.1332	285.4300	30.1386
285.4400	30.1440	285.4500	30.1494	285.4600	30.1548	285.4700	30.1603
285.4800	30.1657	285.4900	30.1711	285.5000	30.1765	285.5100	30.1819
285.5200	**30.1874**	285.5300	30.1928	285.5400	30.1982	285.5500	30.2036
285.5600	30.2090	285.5700	30.2145	285.5800	30.2199	285.5900	30.2253
285.6000	30.2307	285.6100	30.2362	285.6200	30.2416	285.6300	30.2470
285.6400	30.2524	285.6500	30.2579	285.6600	30.2633	**285.6700**	**30.2687**
285.6800	30.2741	285.6900	30.2796	285.7000	30.2850	285.7100	30.2904
285.7200	30.2959	285.7300	30.3013	285.7400	30.3067	285.7500	30.3122
285.7600	30.3176	285.7700	30.3230	285.7800	30.3285	**285.7900**	**30.3339**
285.8000	30.3393	285.8100	30.3448	285.8200	30.3502	285.8300	30.3557
285.8400	30.3611	285.8500	30.3665	285.8600	30.3720	285.8700	30.3774
285.8800	30.3829	**285.8900**	**30.3883**	285.9000	30.3937	285.9100	30.3992
285.9200	30.4046	285.9300	30.4101	285.9400	30.4155	285.9500	30.4210
285.9600	30.4264	**285.9700**	**30.4319**	285.9800	30.4373	285.9900	30.4427
286.0000	30.4482	286.0100	30.4536	286.0200	30.4591	286.0300	30.4645
286.0400	30.4700	286.0500	30.4754	286.0600	30.4809	286.0700	30.4864
286.0800	30.4918	286.0900	30.4973	286.1000	30.5027	286.1100	30.5082
286.1200	30.5136	286.1300	30.5191	286.1400	30.5245	286.1500	30.5300
286.1600	30.5355	286.1700	30.5409	286.1800	30.5464	286.1900	30.5518
286.2000	30.5573	286.2100	30.5628	286.2200	30.5682	286.2300	30.5737

286.2400	30.5791	286.2500	30.5846	286.2600	30.5901	286.2700	30.5955
286.2800	30.6010	286.2900	30.6065	286.3000	30.6119	286.3100	30.6174
286.3200	30.6229	286.3300	30.6283	286.3400	30.6338	286.3500	30.6393
286.3600	30.6448	286.3700	30.6502	286.3800	30.6557	286.3900	30.6612
286.4000	30.6666	286.4100	30.6721	286.4200	30.6776	286.4300	30.6831
286.4400	30.6885	286.4500	30.6940	**286.4600**	**30.6995**	286.4700	30.7050
286.4800	30.7105	286.4900	30.7159	286.5000	30.7214	286.5100	30.7269
286.5200	30.7324	286.5300	30.7379	286.5400	30.7433	286.5500	30.7488
286.5600	30.7543	286.5700	30.7598	286.5800	30.7653	286.5900	30.7708
286.6000	30.7762	286.6100	30.7817	286.6200	30.7872	286.6300	30.7927
286.6400	30.7982	286.6500	30.8037	286.6600	30.8092	286.6700	30.8147
286.6800	30.8201	286.6900	30.8256	286.7000	30.8311	286.7100	30.8366
286.7200	30.8421	286.7300	30.8476	286.7400	30.8531	286.7500	30.8586
286.7600	30.8641	286.7700	30.8696	286.7800	30.8751	286.7900	30.8806
286.8000	30.8861	286.8100	30.8916	286.8200	30.8971	286.8300	30.9026
286.8400	30.9081	286.8500	30.9136	286.8600	30.9191	286.8700	30.9246
286.8800	30.9301	286.8900	30.9356	286.9000	30.9411	286.9100	30.9466
286.9200	30.9521	286.9300	30.9576	286.9400	30.9631	286.9500	30.9686
286.9600	30.9741	286.9700	30.9796	286.9800	30.9851	286.9900	30.9906
287.0000	30.9962	287.0000	30.9962	287.0100	31.0017	287.0200	31.0072
287.0300	31.0127	287.0400	31.0182	287.0500	31.0237	287.0600	31.0292
287.0700	31.0347	287.0800	31.0403	287.0900	31.0458	287.1000	31.0513
287.1100	31.0568	287.1200	31.0623	287.1300	31.0678	287.1400	31.0734
287.1500	31.0789	287.1600	31.0844	287.1700	31.0899	287.1800	31.0954
287.1900	31.1010	287.2000	31.1065	287.2100	31.1120	287.2200	31.1175
287.2300	31.1231	287.2400	31.1286	287.2500	31.1341	287.2600	31.1396
287.2700	**31.1452**	287.2800	31.1507	287.2900	31.1562	287.3000	31.1617
287.3100	31.1673	287.3200	31.1728	287.3300	31.1783	287.3400	31.1839

APPENDIX D. AUXILIARY PROGRAM (SEARAD CODE)

A. INTRODUCTION

"SEARAD" is a FORTRAN computer code that predicts the radiance (brightness) of the ocean surface. SEARAD" is valid for a spectral range extending from the visible to the far infrared regime. It is a self-contained, DOS-compatible program that runs on a personal computer and calculates sea radiance. It is a modified version of the Air Force program MODTRAN2 code that predicts sea radiance between 52.63 and 25000 cm^{-1}. MODTRAN is a computer code designed to determine atmospheric transmission and radiance at moderate resolution from 0 to 50,000 cm^{-1} . SEARAD is based on the Cox-Munk (Cox and Munk, 1954,1956) statistical model for wind-driven capillary wave facets. Preliminary comparisons show that SEARAD agrees to within several °C with actual sea radiance measurements in the mid-wave and long-wave in the infrared band.[Ref.1]

B. UNZIP SEARAD (INSTALLATION)

The following statement tells how to unzip and run "SEARAD". The zipped files span three disks altogether. The last disk will be disk 3; the first disk will be disk 1. These commands assume that the hard disk in the computer is drive c:, and that the 3 1/2 inch disks will be loaded into drive a:. If another drive is used instead for the 3 1/2 disks, the drive letter (b: for example) should be substituted for a: in the following instructions.

Sentences in parentheses are physical acts; sentences without parentheses are commands that should be typed on the keyboard.

To unzip:

c:\ mkdir searad

cd searad (Insert disk1 in drive a:)

copy a:\pkunzip.exe

pkunzip a:\source

pkunzip a:\input

pkunzip a:\exe (Follow instructions for disk insertion.)

The files should all be unzipped at this point. The directory c:\searad should now contain:

zip utility : pkunzip.exe

source code : Modnn [nn=10 to 22] (except mod21.for)

Input file : Tape5xxx.std

Log of mods : Note.txt

Executables : Searad.exe, Dirac, and DOSxmsf.exe

To run Searad :

copy tape5rad.std tape5

searad

type out

This should show the output file corresponding to the input file " Tape5rad.std ".[Ref.5]

C. SEARAD SAMPLE DESCRIPTION

In this section an example is provided to show how to use SEARAD to predict ocean radiance. An input file called " Tape5rad.std " employs a 1976 U.S. standard atmosphere to calculate ocean radiance observed at a zenith angle of 100 degree from a height of 23 m. The Navy aerosol model is used. The calculation is done with multiple scattering at low spectral resolution (LOWTRAN 7) for a single wave number (945 cm^{-1}) in the long wave band. The following DOS commands will calculate ocean radiance and print results

copy tape5rad.std tape5

searad

type out

These commands produce an output file called "out". The four contributions to ocean radiance (path to footprint, sea emission, sky reflection, and sun glint) are listed at the end of the "out" file. "TBOUND" in the input file here is interpreted as sea temperature.

D. SEARAD MODEL

The SEARAD model computes four contributions to sea radiance. The assumption for the model is that the strength of interaction between an optical ray and a capillary wave facet is given by the facet area projected normal to the ray. It does not include multiple reflections, shadowing and gravity waves. It also ignores polarization.

The first contribution is path radiance (N_{path}). The footprint of a single pixel in an image of the sea is indicated by the wavy line. The footprint is observed by a receiver at the end of a ray whose zenith angle at the footprint is θ_r . N_{path} represents the spectral radiance in W/m^2 /sr/cm along the path from the footprint to the receiver.

The second contribution is reflected sky radiance (N_{sky}). The spectral radiance N_s from part of the sky reaches the footprint along a ray whose zenith angle is θ_s. The contributions are the summation from all portions of the sky after specular reflection by the appropriate facets within the footprint. N_{sky} is the sum leaving the footprint at zenith angle θ_S . During its path to the receiver, N_{sky} is attenuated by the path transmission τ_{path}.

The third contribution is reflected solar radiance (N_{sun}), sun glint . The radiance N_0 from the solar center arrives at the footprint along a path whose zenith angle is θ_o. Within the footprint most facets deflect the solar ray away from the receiver and are rejected, but some facets are retained because they deflect the ray specularly toward the receiver along a path with zenith angle θ_r. N_{sun} is the spectral radiance leaving the footprint after summation over rays arriving from all portions of the solar disk. N_{sun} is also attenuated by the path transmission τ_{path}.

The fourth contribution is thermal black body emission (N_{sea}). In this portion each facet emits a spectral radiance N_{bb} given by Planck's equation for a black body. The sea temperature is equal to the value of TBOUND in the input file. The spectral emissivity of a given facet in the direction of the receiver is specified by the slope of that facet and the value of θ_r. N_{sea} is the thermal spectral radiance leaving the footprint for the

receiver after summation over all facets within the footprint. N_{sea} is also attenuated by path transmission τ_{path} after leaving the footprint.

The symbol ρ represents the reflectivity of sea water. It is calculated from Fresnel's equations. The total spectral radiance $N(\nu)$ received at wave number ν (cm^{-1}) is given by

$$N(\nu) = N_{path}(\nu)f(\nu) + \left[N_{sky}(\nu) + N_{sun}(\nu) + N_{sea}(\nu)\right]\tau_{path}(\nu)f(\nu) \ , \qquad (C.1)$$

where $f(\nu)$ stands for the spectral responsivity of the receiver.

The design of SEARAD is such that the path (N_{path}, τ_{path}) and source (N_S, N_O, N_{bb}) values are taken from the original MODTRAN 2 while Fresnel reflection (ρ) and slope integrated values (N_{sky} ,N_{sun}, N_{sea}) are introduced in new subroutines. Integration of Equation (C.1) over the wave number band specified in the input file (Tape5) is implemented in a modification of subroutine "TRAN" to produce the band integrated values for sea radiance given in the output file (out).[Ref.1]

APPENDIX E. DESCRIPTION OF EACH CARD IN SEARAD INPUT FILE

The format of input file is very important. Each number must be in the correct row and column. Below is a listing of the input file parameters in SEARAD and the values used in evaluating the sea radiance.

CARD 1 (line one)

F ⇒ use LOWTRAN 7

7 ⇒ MODEL : radiosonde data used

3 ⇒ ITYPE : slant path to space

1 ⇒ IEMSCT : program execution in radiance mode

1 ⇒ IMULT : program executed with multiple scattering

"M1,M2,M3" are used to modify or supplement the altitude profiles of temperature and pressure, water vapor, and ozone "M4,M5,M6"

6 ⇒ M1 : default temperature and pressure to specified MODEL atmosphere (M1=1~6)

6 ⇒ M2 : default H_2O to specified MODEL atmosphere (M2=1~6)

6 ⇒ M3 : default ozone to specified MODEL atmosphere (M3=1~6)

6 ⇒ M4 : default CH4 to specified MODEL atmosphere (M4=1~6)

6 ⇒ M5 : default N_2O to specified MODEL atmosphere (M5=1~6)

6 ⇒ M6 : default CO to specified MODEL atmosphere (M6=1~6)

1 ⇒ MDEF use default profile for CO2, O2, NO, SO2, NO2, NH3, HNO3

1 ⇒ IM : radiosonde data to be read initially

1 ⇒ NORPT : minimize printing of transmittance

xx ⇒ TBOUND : boundary temperature (^{o}k)

0.00 ⇒ SALB : surface albedo (0.0 to 1.0)

CARD 2 (line 2)

3 ⇒ IHAZE : navy maritime extinction, sets own VIS.

0 ⇒ ISEASN : Summer for model 7

0 ⇒ IVULCN : default to stratospheric background

3 ⇒ ICSTL : air mass (1 for open ocean - 10 for strong continental influence) ICSTL now allow non-integer values. Integers from 1 to 10 inclusive will be taken as is, while integers from 11 to 300 inclusive will be divided by 10. Integers outside the range of 1 to 300 will be reset to a default value of "3.0".

0 ⇒ ICLD : no clouds or rain

0 ⇒ IVSA : not used

20 ⇒ VIS : meteorological range

1.897⇒ WSS : specifies current wind speed (m/s)

1.603⇒ WHH : 24 hour average wind speed (m/s)

0.00 ⇒ RAINT : rain rate (mm/hr)

0.00 ⇒ GNDALT altitude of surface relative to sea level (km)

CARD 2c (line 3)

33 ⇒ ML : number of atmospheric layers to be inserted (Maximum of 34)

0 ⇒ IRD1 : no read

0 ⇒ IRD2 : no read

text TITLE : user defined text

CARD 2c1 (next 33 line)

xx ⇒ ZMDL : altitude of layer (km)

xx ⇒ P : pressure at layer (mb)

xx ⇒ T ambient temperature (°C)

xx ⇒ JCHAR(RH) : relative humidity (%)

ABH ⇒ set units for P,T,RH

CARD 3 (line 37)

0.006⇒ H1 : initial altitude (FLIR sensor altitude) (km)

0.00 ⇒ H2 : final altitude (seasurface altitude) (km)

xx ⇒ ANGLE : zenith angle (degree)

0.000⇒ RANGE : path length (km)

0.000⇒ BETA : earth center angle subtented by H1 and H2 (degree)

0.000⇒ RO : default radius of earth (km)

1 ⇒ LEN for long path through tangent height

90.00⇒ Psi : azimuth of the upwind direction from line of sight positive East of North (degree) 90 $^{\circ}$ means that the wind is blowing from right to left, perpendicular to the direction of observation

T ⇒ True : sea radiance will be carried out (F means that sea radiance will be prevented under all conditions)

CARD 4 (line 38)

830 ⇒ V1 : initial wave number (cm^{-1})

1250 ⇒ V2 : final wave number (cm^{-1})

10 ⇒ DV : wave number increment (cm^{-1})

2 ⇒ filter

CARD 5

0 ⇒ IRPT : end program (3 means read CARD 3 again)

APPENDIX F. SEARAD INPUT DATA

EOMET95 Data Set from NPS Boundary Layer Meteorology Group

```
                        Header Entries form Appendix E

F   7    3    1    1    6    6    6    6    6    6    1    1    1  286.60    0.00
    3    0    0    3    0    0   10.000    1.897     1.603       .000      .000
   33    0    0      11:37:53 MAY 1995
      0.003  1013.400    12.100     90.0                      ABH
      0.017  1011.700    13.300     70.0                      ABH
      0.021  1011.300    13.000     72.0                      ABH
      0.031  1010.100    12.900     74.0                      ABH
      0.042  1008.800    12.800     75.0                      ABH
      0.046  1008.300    12.800     76.0                      ABH
      0.056  1007.100    12.600     77.0                      ABH
      0.070  1005.300    12.500     78.0                      ABH
      0.075  1004.900    12.500     78.0                      ABH
      0.083  1003.900    12.500     77.0                      ABH
      0.093  1002.600    12.500     75.0                      ABH
      0.103  1001.400    12.500     74.0                      ABH
      0.113  1000.200    12.500     73.0                      ABH
      0.119   999.500    12.400     73.0                      ABH
      0.128   998.500    12.400     73.0                      ABH
      0.137   997.400    12.500     73.0                      ABH
      0.150   995.800    12.500     73.0                      ABH
      0.153   995.500    12.700     72.0                      ABH
      0.160   994.600    12.800     70.0                      ABH
      0.164   994.100    12.800     70.0                      ABH
      0.185   991.700    12.800     69.0                      ABH
      0.190   991.100    12.800     69.0                      ABH
      0.201   989.800    12.800     69.0                      ABH
      0.208   988.900    12.700     69.0                      ABH
      0.218   987.800    12.600     69.0                      ABH
      0.228   986.600    12.600     69.0                      ABH
      0.234   985.900    12.500     69.0                      ABH
      0.244   984.700    12.400     69.0                      ABH
      0.256   983.300    12.300     68.0                      ABH
      0.266   982.100    12.300     69.0                      ABH
      0.275   981.100    12.100     69.0                      ABH
      0.283   980.100    12.100     69.0                      ABH
      0.291   979.200    12.100     69.0                      ABH
      0.006     0.000    90.240     .000      .000      0.00    1   252.000     T
        830      1250        10        1
    0
```

```
F    7     3     1     1     6     6     6     6     6     6     1     1     1  286.60    0.00
     3     0     0     3     0     0    10.000     1.897     1.603      .000      .000
    33     0     0      typical case
       0.003  1013.400     12.100     90.0                         ABH
       0.017  1011.700     13.300     70.0                         ABH
       0.021  1011.300     13.000     72.0                         ABH
       0.031  1010.100     12.900     74.0                         ABH
       0.042  1008.800     12.800     75.0                         ABH
       0.046  1008.300     12.800     76.0                         ABH
       0.056  1007.100     12.600     77.0                         ABH
       0.070  1005.300     12.500     78.0                         ABH
       0.075  1004.900     12.500     78.0                         ABH
       0.083  1003.900     12.500     77.0                         ABH
       0.093  1002.600     12.500     75.0                         ABH
       0.103  1001.400     12.500     74.0                         ABH
       0.113  1000.200     12.500     73.0                         ABH
       0.119   999.500     12.400     73.0                         ABH
       0.128   998.500     12.400     73.0                         ABH
       0.137   997.400     12.500     73.0                         ABH
       0.150   995.800     12.500     73.0                         ABH
       0.153   995.500     12.700     72.0                         ABH
       0.160   994.600     12.800     70.0                         ABH
       0.164   994.100     12.800     70.0                         ABH
       0.185   991.700     12.800     69.0                         ABH
       0.190   991.100     12.800     69.0                         ABH
       0.201   989.800     12.800     69.0                         ABH
       0.208   988.900     12.700     69.0                         ABH
       0.218   987.800     12.600     69.0                         ABH
       0.228   986.600     12.600     69.0                         ABH
       0.234   985.900     12.500     69.0                         ABH
       0.244   984.700     12.400     69.0                         ABH
       0.256   983.300     12.300     68.0                         ABH
       0.266   982.100     12.300     69.0                         ABH
       0.275   981.100     12.100     69.0                         ABH
       0.283   980.100     12.100     69.0                         ABH
       0.291   979.200     12.100     69.0                         ABH
       0.006     0.000     90.043     .000      .000      0.00     1    252.000      T
         830      1250         10        1
     0
```

```
F   7    3    1    1    6    6    6    6    6    6    1    1    1  286.60    0.00
    3    0    0    3    0    0   10.000    1.897    1.603      .000      .000
   33    0    0    MDR Estimate-1
      0.003  1013.400   12.100     90.0                      ABH
      0.017  1011.700   13.300     70.0                      ABH
      0.021  1011.300   13.000     72.0                      ABH
      0.031  1010.100   12.900     74.0                      ABH
      0.042  1008.800   12.800     75.0                      ABH
      0.046  1008.300   12.800     76.0                      ABH
      0.056  1007.100   12.600     77.0                      ABH
      0.070  1005.300   12.500     78.0                      ABH
      0.075  1004.900   12.500     78.0                      ABH
      0.083  1003.900   12.500     77.0                      ABH
      0.093  1002.600   12.500     75.0                      ABH
      0.103  1001.400   12.500     74.0                      ABH
      0.113  1000.200   12.500     73.0                      ABH
      0.119   999.500   12.400     73.0                      ABH
      0.128   998.500   12.400     73.0                      ABH
      0.137   997.400   12.500     73.0                      ABH
      0.150   995.800   12.500     73.0                      ABH
      0.153   995.500   12.700     72.0                      ABH
      0.160   994.600   12.800     70.0                      ABH
      0.164   994.100   12.800     70.0                      ABH
      0.185   991.700   12.800     69.0                      ABH
      0.190   991.100   12.800     69.0                      ABH
      0.201   989.800   12.800     69.0                      ABH
      0.208   988.900   12.700     69.0                      ABH
      0.218   987.800   12.600     69.0                      ABH
      0.228   986.600   12.600     69.0                      ABH
      0.234   985.900   12.500     69.0                      ABH
      0.244   984.700   12.400     69.0                      ABH
      0.256   983.300   12.300     68.0                      ABH
      0.266   982.100   12.300     69.0                      ABH
      0.275   981.100   12.100     69.0                      ABH
      0.283   980.100   12.100     69.0                      ABH
      0.291   979.200   12.100     69.0                      ABH
      0.250     0.000   95.000     .000      .000     0.00    1    252.000      T
        830      1250       10        1
    0
```

```
F   7    3    1    1    6    6    6    6    6    6    1    1    1  286.60    0.00
    3    0    0    3    0    0   10.000    1.897    1.603     .000     .000
   33    0    0    MDR Estimate-2
     0.003  1013.400   12.100     90.0                    ABH
     0.017  1011.700   13.300     70.0                    ABH
     0.021  1011.300   13.000     72.0                    ABH
     0.031  1010.100   12.900     74.0                    ABH
     0.042  1008.800   12.800     75.0                    ABH
     0.046  1008.300   12.800     76.0                    ABH
     0.056  1007.100   12.600     77.0                    ABH
     0.070  1005.300   12.500     78.0                    ABH
     0.075  1004.900   12.500     78.0                    ABH
     0.083  1003.900   12.500     77.0                    ABH
     0.093  1002.600   12.500     75.0                    ABH
     0.103  1001.400   12.500     74.0                    ABH
     0.113  1000.200   12.500     73.0                    ABH
     0.119   999.500   12.400     73.0                    ABH
     0.128   998.500   12.400     73.0                    ABH
     0.137   997.400   12.500     73.0                    ABH
     0.150   995.800   12.500     73.0                    ABH
     0.153   995.500   12.700     72.0                    ABH
     0.160   994.600   12.800     70.0                    ABH
     0.164   994.100   12.800     70.0                    ABH
     0.185   991.700   12.800     69.0                    ABH
     0.190   991.100   12.800     69.0                    ABH
     0.201   989.800   12.800     69.0                    ABH
     0.208   988.900   12.700     69.0                    ABH
     0.218   987.800   12.600     69.0                    ABH
     0.228   986.600   12.600     69.0                    ABH
     0.234   985.900   12.500     69.0                    ABH
     0.244   984.700   12.400     69.0                    ABH
     0.256   983.300   12.300     68.0                    ABH
     0.266   982.100   12.300     69.0                    ABH
     0.275   981.100   12.100     69.0                    ABH
     0.283   980.100   12.100     69.0                    ABH
     0.291   979.200   12.100     69.0                    ABH
     0.250     0.000   90.550     .000     .000     0.00    1   252.000    T
       830      1250       10        1
    0
```

APPENDIX G. SEARAD OUTPUT DATA

```
          ***** SEARAD, A MODIFICATION OF LOWTRAN7 *****

DATE: 11/21/1997                                  TIME: 12:00:50.69

THERMAL RADIANCE MODE

MULTIPLE SCATTERING USED

MARINE AEROSOL MODEL USED

         WIND SPEED          =     1.90 M/SEC
         WIND SPEED          =     1.60 M/SEC, 24 HR AVERAGE
         RELATIVE HUMIDITY =      89.93 PERCENT
         AIRMASS CHARACTER =       3
         VISIBILITY          =    10.00 KM

SLANT PATH TO SPACE

          H1       =        .006 KM
          HMIN     =        .000 KM
          ANGLE    =      90.240 DEG

FREQUENCY RANGE

          IV1      =          830 CM-1   (   12.05 MICROMETERS)
          IV2      =         1250 CM-1   (    8.00 MICROMETERS)
          IDV      =           10 CM-1
          IFWHM    =            1 CM-1
          IFILTER =             0

SUMMARY OF THE GEOMETRY CALCULATION

          H1       =        .006 KM
          H2       =        .000 KM
          ANGLE    =      90.240 DEG
          RANGE    =       1.444 KM
          BETA     =        .013 DEG
          PHI      =      89.764 DEG
          HMIN     =        .000 KM
          BENDING =         .009 DEG
          LEN      =            0

SEA AT 286.60 K REPLACES BLACK BODY BOUNDARY

          UPWIND   =     252.000 DEG EAST OF LINE OF SIGHT

ZERO RANGE VALUES

          SEA EMISSION               =  14.42182 W M-2 SR-1   (AV. EMISS.
.4636)
          SKY REFLECTION             =   5.22488 W M-2 SR-1
          SUN GLINT                  =    .00000 W M-2 SR-1
```

```
         TOTAL RADIANCE           =  19.64670 W M-2 SR-1
         BLACK BODY TEMP.         =     -10.1 C

FULL RANGE VALUES

         PATH TO FOOTPRINT        =   7.95021 W M-2 SR-1  (AV. TRANS.
.7181)
         SEA EMISSION             =  10.50470 W M-2 SR-1
         SKY REFLECTION           =   3.70776 W M-2 SR-1
         SUN GLINT                =    .00000 W M-2 SR-1

         TOTAL RADIANCE           =  22.16267 W M-2 SR-1
         BLACK BODY TEMP.         =      -4.3 C
```

```
                ***** SEARAD, A MODIFICATION OF LOWTRAN7 *****

DATE: 11/21/1997                                        TIME: 12:03:37.72

THERMAL RADIANCE MODE

MULTIPLE SCATTERING USED

MARINE AEROSOL MODEL USED

         WIND SPEED         =      1.90 M/SEC
         WIND SPEED         =      1.60 M/SEC, 24 HR AVERAGE
         RELATIVE HUMIDITY  =     89.93 PERCENT
         AIRMASS CHARACTER  =      3
         VISIBILITY         =     10.00 KM

SLANT PATH TO SPACE

          H1       =       .006 KM
          HMIN     =       .000 KM
          ANGLE    =     90.043 DEG

FREQUENCY RANGE

          IV1      =        830 CM-1  (  12.05 MICROMETERS)
          IV2      =       1250 CM-1  (   8.00 MICROMETERS)
          IDV      =         10 CM-1
          IFWHM    =          1 CM-1
          IFILTER  =          0

SUMMARY OF THE GEOMETRY CALCULATION

          H1       =       .006 KM
          H2       =       .291 KM
          ANGLE    =     90.043 DEG
          RANGE    =     97.261 KM
          BETA     =       .875 DEG
          PHI      =     90.487 DEG
          HMIN     =       .000 KM
          BENDING  =       .344 DEG
          LEN      =          1

TBOUND SET TO     .10 K FOR MARINE SKY

INTEGRATED ABSORPTION    =    420.00 CM-1 FROM  830 TO 1250 CM-1
AVERAGE TRANSMITTANCE    =       .0000
MAXIMUM RADIANCE         =  1.033E-01 W M-2 SR-1 (CM-1)-1 AT   830.0 CM-1
MINIMUM RADIANCE         =  4.248E-02 W M-2 SR-1 (CM-1)-1 AT  1250.0 CM-1
BOUNDARY TEMPERATURE     =        .10 K
BOUNDARY EMISSIVITY      =      1.000
FILTERED RADIANCE        =  2.904E+01 W M-2 SR-1
BLACKBODY TEMPERATURE    =        9.8 C
```

```
          ***** SEARAD, A MODIFICATION OF LOWTRAN7 *****

DATE: 11/21/1997                                        TIME: 12:06:44.19

THERMAL RADIANCE MODE

MULTIPLE SCATTERING USED

MARINE AEROSOL MODEL USED

         WIND SPEED         =     1.90 M/SEC
         WIND SPEED         =     1.60 M/SEC, 24 HR AVERAGE
         RELATIVE HUMIDITY  =    89.93 PERCENT
         AIRMASS CHARACTER  =     3
         VISIBILITY         =    10.00 KM

SLANT PATH TO SPACE

          H1       =        .250 KM
          HMIN     =        .000 KM
          ANGLE    =      95.000 DEG

FREQUENCY RANGE

          IV1      =         830 CM-1  (  12.05 MICROMETERS)
          IV2      =        1250 CM-1  (   8.00 MICROMETERS)
          IDV      =          10 CM-1
          IFWHM    =           1 CM-1
          IFILTER  =           0

SUMMARY OF THE GEOMETRY CALCULATION

          H1       =        .250 KM
          H2       =        .000 KM
          ANGLE    =      95.000 DEG
          RANGE    =       2.875 KM
          BETA     =        .026 DEG
          PHI      =      85.020 DEG
          HMIN     =        .000 KM
          BENDING  =        .006 DEG
          LEN      =           0

SEA AT 286.60 K REPLACES BLACK BODY BOUNDARY

          UPWIND   =     252.000 DEG EAST OF LINE OF SIGHT

ZERO RANGE VALUES

          SEA EMISSION           =  18.29033 W M-2 SR-1   (AV. EMISS.
.5882)
          SKY REFLECTION         =   3.71435 W M-2 SR-1
          SUN GLINT              =    .00000 W M-2 SR-1

          TOTAL RADIANCE         =  22.00468 W M-2 SR-1
          BLACK BODY TEMP.       =      -4.7 C

FULL RANGE VALUES
```

```
          PATH TO FOOTPRINT      =  10.91463 W M-2 SR-1  (AV. TRANS.
.6154)
          SEA EMISSION           =  11.46502 W M-2 SR-1
          SKY REFLECTION         =   2.24949 W M-2 SR-1
          SUN GLINT              =    .00000 W M-2 SR-1

          TOTAL RADIANCE         =  24.62915 W M-2 SR-1
          BLACK BODY TEMP.       =       1.1 C
```

```
***** SEARAD, A MODIFICATION OF LOWTRAN7 *****

DATE: 11/21/1997                                    TIME: 12:09:01.17

THERMAL RADIANCE MODE

MULTIPLE SCATTERING USED

MARINE AEROSOL MODEL USED

         WIND SPEED          =    1.90 M/SEC
         WIND SPEED          =    1.60 M/SEC, 24 HR AVERAGE
         RELATIVE HUMIDITY =     89.93 PERCENT
         AIRMASS CHARACTER =      3
         VISIBILITY          =   10.00 KM

SLANT PATH TO SPACE

          H1       =       .250 KM
          HMIN     =       .000 KM
          ANGLE    =     90.550 DEG

FREQUENCY RANGE

          IV1      =        830 CM-1  (  12.05 MICROMETERS)
          IV2      =       1250 CM-1  (   8.00 MICROMETERS)
          IDV      =         10 CM-1
          IFWHM    =          1 CM-1
          IFILTER =           0

SUMMARY OF THE GEOMETRY CALCULATION

          H1       =       .250 KM
          H2       =       .000 KM
          ANGLE    =     90.550 DEG
          RANGE    =     33.415 KM
          BETA     =       .300 DEG
          PHI      =     89.683 DEG
          HMIN     =       .000 KM
          BENDING =        .067 DEG
          LEN      =          0

SEA AT 286.60 K REPLACES BLACK BODY BOUNDARY

          UPWIND   =    252.000 DEG EAST OF LINE OF SIGHT

ZERO RANGE VALUES

          SEA EMISSION           =  14.46294 W M-2 SR-1   (AV. EMISS.
.4649)
          SKY REFLECTION         =   5.26282 W M-2 SR-1
          SUN GLINT              =    .00000 W M-2 SR-1

          TOTAL RADIANCE         =  19.72575 W M-2 SR-1
          BLACK BODY TEMP.       =      -9.9 C

FULL RANGE VALUES
```

```
         PATH TO FOOTPRINT     =  28.50598 W M-2 SR-1  (AV. TRANS.
.0171)
         SEA EMISSION          =    .24282 W M-2 SR-1
         SKY REFLECTION        =    .07884 W M-2 SR-1
         SUN GLINT             =    .00000 W M-2 SR-1

         TOTAL RADIANCE        =  28.82764 W M-2 SR-1
         BLACK BODY TEMP.      =       9.5 C
```

APPENDIX H. GPS DATA

Source: EOMET95 Data Set

ws: wind speed
wd: wind direction
shs: ship seep
shd: ship direction

ta: air temperature
ts: sea temperature
rh: relative humidity
pr: pressure

lat: latitude
lon: longitude

date	time	ws	wd	ta	rh	pr	shs	shd	lat	lon	ts
950515	2030	1.00	153	14.55	70.40	1010	0.01	264	36.80	-121.79	16.90
950515	2040	0.45	204	13.98	72.84	1010	0.02	30	36.80	-121.79	16.50
950515	2050	0.01	309	14.22	72.70	1011	0.02	48	36.80	-121.79	17.60
950515	2100	0.64	243	15.02	69.92	1011	0.01	300	36.80	-121.79	18.20
950515	2110	0.24	274	15.74	70.76	1011	0.05	37	36.80	-121.79	19.10
950515	2120	2.14	275	16.28	68.09	1012	1.24	340	36.81	-121.79	14.20
950515	2130	5.17	240	14.77	76.57	1010	4.77	247	36.80	-121.80	12.30
950515	2140	4.25	248	13.91	82.30	1011	5.11	254	36.80	-121.83	13.10
950515	2150	6.64	258	13.06	87.38	1011	4.84	257	36.79	-121.87	13.40
950515	2200	6.12	261	13.05	87.31	1011	4.71	256	36.78	-121.90	12.40
950515	2210	6.09	274	13.19	85.85	1011	4.56	254	36.78	-121.93	12.30
950515	2220	5.66	289	13.01	86.30	1011	4.53	250	36.77	-121.96	12.70
950515	2230	5.46	299	13.07	83.25	1011	4.46	250	36.76	-121.98	13.00
950515	2240	4.68	304	13.30	81.02	1011	2.59	257	36.75	-122.01	13.50
950515	2250	3.94	300	13.52	82.33	1011	0.50	275	36.75	-122.02	13.80
950515	2300	2.98	298	13.48	84.72	1011	0.51	282	36.75	-122.02	13.90
950515	2310	2.68	302	13.40	84.98	1011	0.59	284	36.76	-122.02	13.90
950515	2320	2.62	314	13.47	84.37	1011	0.58	279	36.76	-122.03	13.90
950515	2330	2.74	331	13.53	84.75	1011	0.59	280	36.76	-122.03	13.90
950515	2340	2.90	308	13.54	85.24	1011	0.55	291	36.76	-122.04	14.10
950515	2350	3.00	294	13.48	86.07	1011	0.49	293	36.76	-122.04	13.90
950516	0	3.01	276	13.23	88.50	1010	0.48	268	36.76	-122.04	13.80
950516	10	3.84	279	12.94	89.52	1010	0.48	258	36.76	-122.05	13.70
950516	20	4.68	287	12.79	88.76	1011	0.50	245	36.76	-122.05	13.60
950516	30	4.67	296	12.73	88.49	1011	0.47	264	36.76	-122.05	13.80
950516	40	3.39	316	12.80	90.10	1011	0.51	281	36.76	-122.06	13.80
950516	50	2.84	307	12.90	89.16	1011	0.48	273	36.76	-122.06	13.90
950516	100	2.56	304	13.03	88.12	1010	0.51	284	36.76	-122.06	13.80
950516	110	2.97	279	12.90	89.18	1010	0.47	280	36.76	-122.06	13.70
950516	120	3.31	277	12.79	89.80	1010	0.47	275	36.76	-122.07	13.60
950516	130	2.20	270	12.76	89.59	1010	0.50	268	36.76	-122.07	13.40
950516	140	2.75	284	12.84	88.16	1010	0.52	273	36.76	-122.07	13.50
950516	150	2.39	292	12.87	88.92	1010	0.55	274	36.76	-122.08	13.30
950516	200	3.15	290	12.82	87.96	1011	0.63	258	36.76	-122.08	13.20
950516	210	3.35	284	12.79	88.42	1011	0.64	261	36.76	-122.09	13.10
950516	220	3.27	278	12.79	89.44	1011	0.60	264	36.76	-122.09	13.00
950516	230	2.70	275	12.73	90.49	1011	0.67	269	36.76	-122.10	12.80
950516	240	2.62	259	12.74	91.73	1011	0.89	241	36.76	-122.10	12.80
950516	250	1.90	259	12.79	91.96	1011	1.00	242	36.75	-122.11	13.10
950516	300	2.34	206	12.81	91.82	1011	1.05	242	36.75	-122.11	13.20
950516	310	3.64	207	12.69	91.33	1011	0.78	249	36.75	-122.12	12.90
950516	320	4.18	201	12.72	90.70	1011	0.79	249	36.75	-122.12	12.80
950516	330	3.89	190	12.74	89.32	1011	0.75	243	36.75	-122.13	13.00
950516	340	4.13	207	12.79	88.34	1011	0.76	251	36.74	-122.13	13.10

950516	420	3.23	244	12.82	89.98	1011	0.82	254	36.74	-122.15	13.40
950516	430	3.52	245	12.77	90.73	1011	0.76	255	36.74	-122.16	13.50
950516	440	3.45	252	12.77	90.58	1011	0.78	254	36.74	-122.16	13.40
950516	450	3.09	264	12.72	90.53	1011	0.81	261	36.74	-122.17	13.30
950516	500	2.90	263	12.72	90.76	1011	0.88	259	36.74	-122.17	13.20
950516	510	2.83	254	12.67	91.26	1011	0.90	262	36.73	-122.18	13.10
950516	520	2.98	245	12.66	92.01	1011	0.91	265	36.73	-122.18	13.20
950516	530	2.07	254	12.62	92.70	1011	0.88	263	36.73	-122.19	13.10
950516	540	2.32	261	12.59	93.39	1012	0.92	260	36.73	-122.20	13.10
950516	550	2.66	279	12.58	93.88	1012	0.97	261	36.73	-122.20	13.00
950516	600	2.48	279	12.55	94.00	1012	0.94	257	36.73	-122.21	12.90
950516	610	1.79	308	12.55	94.07	1011	0.77	247	36.73	-122.21	12.90
950516	620	1.67	318	12.49	94.98	1011	0.80	253	36.73	-122.22	13.00
950516	630	1.96	358	12.36	95.72	1011	0.83	251	36.73	-122.22	13.00
950516	640	2.18	36	12.26	95.94	1011	0.82	258	36.73	-122.23	13.00
950516	650	1.51	53	12.20	95.95	1011	0.81	258	36.72	-122.23	12.90
950516	700	1.45	61	12.14	96.00	1011	0.77	259	36.72	-122.24	12.80
950516	710	2.11	39	12.19	96.02	1011	0.79	262	36.72	-122.24	12.90
950516	720	2.53	3	12.23	96.02	1011	0.78	262	36.72	-122.25	13.00
950516	730	2.68	338	12.30	96.11	1011	0.73	256	36.72	-122.26	13.10
950516	740	2.29	332	12.42	96.05	1011	0.77	254	36.72	-122.26	13.30
950516	750	3.23	7	12.38	94.99	1011	0.77	254	36.72	-122.26	13.30
950516	800	3.68	343	12.45	94.50	1011	0.74	251	36.72	-122.27	13.10
950516	810	3.83	344	12.44	94.11	1011	0.74	252	36.72	-122.27	13.00
950516	820	3.65	354	12.37	94.90	1011	0.76	253	36.72	-122.28	13.00
950516	830	3.53	22	12.27	95.60	1011	0.78	268	36.71	-122.28	13.00
950516	840	3.63	25	12.13	95.98	1011	0.79	266	36.71	-122.29	13.00
950516	850	3.88	21	12.09	96.23	1011	0.81	258	36.71	-122.30	13.10
950516	900	4.18	31	12.04	96.50	1011	0.79	261	36.71	-122.30	13.10
950516	910	4.53	53	11.86	96.91	1011	0.87	261	36.71	-122.31	13.00
950516	920	4.45	47	11.81	97.61	1011	0.89	252	36.71	-122.31	13.00
950516	930	3.56	47	11.79	97.98	1011	0.64	260	36.71	-122.32	13.00
950516	940	2.41	57	11.75	98.04	1011	0.26	254	36.71	-122.32	13.10
950516	950	2.63	47	11.65	98.15	1011	1.00	251	36.71	-122.32	13.10
950516	1000	2.56	67	11.69	98.54	1011	0.92	263	36.71	-122.33	13.10
950516	1010	1.68	57	11.73	98.85	1011	0.78	263	36.71	-122.34	13.10
950516	1020	1.72	54	11.76	98.98	1011	0.71	268	36.71	-122.34	13.20
950516	1030	1.70	65	11.80	98.99	1011	0.73	269	36.71	-122.35	13.20
950516	1040	1.69	78	11.74	99.02	1011	0.75	272	36.71	-122.35	13.20
950516	1050	0.95	90	11.79	99.02	1011	0.77	269	36.71	-122.36	13.20
950516	1100	0.91	99	11.96	99.46	1011	0.68	272	36.71	-122.36	13.20
950516	1110	1.23	104	12.13	99.65	1011	0.67	273	36.71	-122.36	13.30
950516	1120	0.59	88	12.12	99.16	1011	0.59	269	36.71	-122.37	13.20
950516	1130	0.63	76	11.96	99.06	1011	0.66	270	36.71	-122.37	13.20
950516	1140	1.30	360	11.85	99.28	1011	0.66	270	36.71	-122.38	13.10
950516	1150	2.03	355	11.83	99.74	1011	0.60	271	36.71	-122.38	13.20
950516	1200	2.17	0	11.84	99.95	1011	0.65	269	36.71	-122.39	13.20
950516	1210	1.96	1	11.80	100.00	1011	0.59	267	36.71	-122.39	13.20
950516	1220	2.34	20	11.81	100.00	1011	0.59	269	36.71	-122.39	13.20
950516	1230	2.26	44	11.80	100.02	1011	0.60	271	36.71	-122.40	13.20
950516	1240	2.09	37	11.64	100.02	1011	0.53	270	36.71	-122.40	13.10
950516	1250	2.42	40	11.70	100.09	1011	0.49	270	36.71	-122.41	13.10
950516	1300	3.18	56	11.60	100.07	1011	1.91	74	36.71	-122.40	13.20
950516	1310	3.29	73	11.58	99.71	1011	4.68	78	36.71	-122.38	13.30
950516	1320	2.15	61	11.43	98.70	1011	4.68	77	36.72	-122.35	13.10
950516	1330	1.94	61	11.36	97.50	1011	4.76	77	36.72	-122.32	13.10
950516	1340	2.24	74	11.38	96.42	1011	4.83	80	36.73	-122.29	13.00
950516	1350	2.70	83	11.40	95.96	1011	4.81	81	36.73	-122.25	12.90
950516	1400	1.72	79	11.31	95.69	1011	4.74	82	36.73	-122.22	12.70
950516	1410	1.79	68	11.28	95.62	1011	4.63	82	36.74	-122.19	12.70
950516	1420	2.48	63	11.21	94.65	1011	4.74	78	36.74	-122.16	12.70
950516	1430	2.17	57	11.30	93.32	1011	4.86	78	36.75	-122.13	12.80
950516	1440	2.67	37	11.39	93.54	1012	4.95	80	36.75	-122.10	13.10

950516	1450	2.53	36	11.37	93.59	1012	4.98	81	36.76	-122.06	12.90
950516	1500	2.27	42	11.33	95.13	1012	4.93	80	36.76	-122.03	12.80
950516	1510	2.19	32	11.21	95.21	1011	4.87	79	36.77	-122.00	12.90
950516	1520	1.83	57	11.13	94.04	1011	4.85	79	36.77	-121.97	12.60
950516	1530	0.72	75	11.05	94.85	1012	5.01	77	36.78	-121.93	12.30
950516	1540	0.91	83	10.92	93.78	1011	5.10	77	36.78	-121.90	12.60
950516	1550	0.69	91	10.88	92.17	1011	5.16	76	36.79	-121.87	12.70
950516	1600	0.66	257	11.02	92.16	1012	5.13	76	36.79	-121.83	13.20
950516	1610	2.22	266	11.31	92.04	1012	4.79	64	36.80	-121.80	13.20
950516	1620	2.20	281	11.75	90.69	1012	1.23	187	36.80	-121.79	15.80
950516	1630	0.72	216	11.92	89.46	1012	0.04	107	36.80	-121.79	19.90
950516	1640	1.50	298	11.96	87.99	1012	0.32	52	36.80	-121.79	16.50
950516	1650	2.93	287	11.94	89.66	1012	1.70	251	36.81	-121.79	13.90
950516	1700	2.09	289	11.75	91.78	1011	0.38	26	36.80	-121.80	12.60
950516	1710	1.96	238	12.08	90.68	1012	0.38	32	36.80	-121.80	13.30
950516	1720	2.53	308	12.10	91.00	1012	0.68	8	36.81	-121.80	13.60
950516	1730	2.85	317	12.00	90.94	1012	0.78	330	36.81	-121.80	13.30
950516	1740	2.23	345	11.92	91.28	1012	0.31	274	36.81	-121.80	12.50
950516	1750	2.49	279	12.05	90.49	1012	0.58	174	36.81	-121.80	13.30
950516	1800	2.98	248	12.30	90.04	1012	0.36	95	36.81	-121.80	13.50
950516	1810	3.35	275	12.41	89.91	1012	2.15	280	36.81	-121.80	13.60
950516	1820	2.53	341	12.11	92.24	1012	0.15	339	36.81	-121.81	13.40
950516	**1830**	**2.92**	**230**	**12.15**	**92.58**	**1012**	**0.27**	**172**	**36.81**	**-121.81**	**13.60**
950516	**1840**	**3.69**	**252**	**12.30**	**93.34**	**1012**	**0.66**	**106**	**36.81**	**-121.81**	**13.60**
950516	1850	0.08	321	12.64	92.91	1012	0.20	87	36.81	-121.80	13.70
950516	1900	4.50	274	12.49	93.33	1012	0.58	311	36.81	-121.80	13.50
950516	1910	4.68	261	12.29	93.87	1012	4.15	256	36.81	-121.82	13.70
950516	1920	4.69	272	12.23	94.21	1012	4.71	252	36.80	-121.85	13.80
950516	1930	6.03	281	12.08	93.71	1012	4.71	251	36.79	-121.88	13.00
950516	1940	10.26	288	11.98	92.91	1011	4.70	248	36.78	-121.91	12.40
950516	1950	10.49	292	12.04	92.26	1011	4.56	251	36.78	-121.94	12.40
950516	2000	10.37	292	12.15	92.28	1011	4.62	251	36.77	-121.97	12.50
950516	2010	10.31	292	12.16	91.94	1011	4.57	249	36.76	-122.00	12.90
950516	2020	9.59	265	12.18	91.22	1012	0.93	232	36.75	-122.01	13.00
950516	2030	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.10
950516	2040	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.20
950516	2050	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.30
950517	1200	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.50
950517	1210	3.30	3	12.08	88.67	1014	0.62	341	36.70	-122.39	13.50
950517	1220	3.76	338	12.04	88.82	1013	0.70	330	36.71	-122.39	13.50
950517	1230	3.46	338	12.04	88.29	1013	0.75	324	36.71	-122.39	13.50
950517	1240	3.19	339	11.99	89.30	1014	0.80	338	36.71	-122.39	13.50
950517	1250	3.62	341	11.95	89.75	1014	3.73	78	36.72	-122.38	13.50
950517	1300	3.06	359	11.93	88.38	1014	4.60	82	36.72	-122.35	13.40
950517	1310	3.61	355	11.90	88.07	1014	4.62	83	36.72	-122.32	13.30
950517	1320	3.63	352	11.89	87.68	1014	4.58	83	36.73	-122.29	13.20
950517	1330	3.29	358	11.78	87.85	1014	4.71	83	36.73	-122.26	13.10
950517	1340	3.13	1	11.70	86.64	1014	4.82	83	36.73	-122.23	12.90
950517	1350	2.88	25	11.57	86.27	1014	4.72	81	36.74	-122.20	12.80
950517	1400	2.47	21	11.49	85.74	1014	4.70	82	36.74	-122.16	12.80
950517	1410	1.74	14	11.48	86.56	1014	4.76	80	36.74	-122.13	12.60
950517	1420	1.63	342	11.49	86.48	1014	4.79	79	36.75	-122.10	12.70
950517	1430	2.01	347	11.46	87.93	1014	4.84	78	36.75	-122.07	12.90
950517	1440	1.51	10	11.42	90.04	1014	4.81	78	36.76	-122.04	12.90
950517	1450	0.96	56	11.41	90.47	1014	4.71	79	36.76	-122.01	12.70
950517	1500	0.97	350	11.35	91.46	1015	4.81	79	36.77	-121.98	12.60
950517	1510	1.48	342	11.31	92.19	1015	4.79	77	36.77	-121.94	12.50
950517	1520	1.66	315	11.28	92.22	1015	4.90	75	36.78	-121.91	13.40
950517	1530	2.40	307	11.36	92.02	1015	4.96	76	36.79	-121.88	13.60
950517	1540	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.60
950517	1550	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.40
950517	1600	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.90

950517	1610	1.79	314	11.55	92.30	1015	0.60	195	36.81	-121.80	14.00
950517	1620	1.58	349	11.47	92.42	1015	0.24	323	36.81	-121.80	14.00
950517	1630	3.39	288	11.47	92.48	1015	0.80	282	36.81	-121.80	14.00
950517	1640	2.62	284	11.47	92.18	1015	0.83	277	36.81	-121.81	14.10
950517	1650	2.51	288	11.52	92.25	1015	1.22	275	36.81	-121.82	13.70
950517	1700	2.58	290	11.50	92.08	1015	1.64	277	36.81	-121.82	13.60
950517	1710	1.07	278	11.60	91.72	1016	0.18	260	36.81	-121.83	13.80
950517	1720	1.59	306	11.78	90.44	1016	0.84	272	36.81	-121.83	13.80
950517	1730	1.38	332	11.85	90.01	1015	0.46	255	36.81	-121.84	14.00
950517	1740	0.99	278	12.40	88.37	1016	0.60	88	36.81	-121.83	14.10
950517	1750	1.94	272	12.76	86.46	1016	1.41	96	36.81	-121.82	13.90
950517	1800	1.96	273	12.87	83.67	1016	1.53	96	36.81	-121.81	14.00
950517	1810	2.31	274	12.81	83.26	1016	1.10	85	36.81	-121.81	14.10
950517	1820	2.13	270	12.77	83.23	1016	0.76	93	36.81	-121.80	14.40
950517	1830	3.18	273	12.37	84.44	1015	2.00	253	36.80	-121.80	13.90
950517	1840	3.81	272	11.80	86.42	1015	4.34	253	36.80	-121.82	13.70
950517	1850	4.14	271	11.69	86.96	1015	4.25	253	36.79	-121.85	13.90
950517	1900	2.83	253	11.66	86.41	1016	4.19	253	36.79	-121.88	13.90
950517	1910	2.97	254	11.68	86.78	1016	4.28	252	36.78	-121.91	13.50
950517	1920	4.16	264	11.68	87.65	1016	4.26	251	36.77	-121.93	13.00
950517	1930	4.25	276	11.68	88.83	1016	4.20	266	36.77	-121.96	13.00
950517	1940	4.16	275	11.66	89.88	1016	3.74	245	36.76	-121.99	13.00
950517	1950	4.23	271	11.62	90.72	1016	1.09	258	36.76	-122.00	13.10
950517	2000	4.31	269	11.65	90.82	1016	0.94	256	36.76	-122.01	13.20
950517	2010	3.88	260	11.77	91.52	1016	0.95	252	36.76	-122.01	13.20
950517	2020	3.69	257	11.89	92.36	1016	0.86	249	36.76	-122.02	13.30
950517	2030	4.40	259	11.89	93.66	1016	0.87	258	36.75	-122.03	13.30
950517	2040	4.41	245	11.85	94.60	1016	0.82	244	36.75	-122.03	13.30
950517	2050	4.58	248	11.89	95.48	1016	0.79	248	36.75	-122.04	13.40
950517	2100	4.74	256	11.91	95.87	1016	0.74	253	36.75	-122.04	13.40
950517	2110	4.56	258	11.98	95.89	1016	0.79	246	36.75	-122.05	13.40
950517	2120	4.93	263	12.04	95.49	1015	0.78	261	36.75	-122.05	13.40
950517	2130	5.38	270	12.05	95.71	1015	0.89	271	36.75	-122.06	13.50
950517	2140	5.21	270	12.15	95.89	1015	0.78	263	36.75	-122.06	13.40
950517	2150	5.44	261	12.20	95.87	1015	0.82	248	36.75	-122.07	13.30
950517	2200	5.84	268	12.20	95.53	1015	0.82	250	36.74	-122.07	13.40
950517	2210	5.03	276	12.17	95.64	1015	0.10	163	36.74	-122.08	13.50
950517	2220	6.16	303	12.12	95.87	1015	2.78	82	36.74	-122.07	13.70
950517	2230	6.04	299	12.06	95.95	1015	2.81	79	36.75	-122.05	13.60
950517	2240	5.83	297	12.03	95.98	1015	2.85	79	36.75	-122.03	13.60
950517	2250	5.20	293	12.08	95.91	1015	2.09	71	36.75	-122.01	13.40
950517	2300	5.79	272	12.09	95.84	1015	0.67	262	36.75	-122.01	13.10
950517	2310	5.86	273	12.07	95.63	1015	0.71	266	36.75	-122.01	13.30
950517	2320	5.90	269	12.08	95.73	1015	0.67	260	36.75	-122.02	13.50
950517	2330	6.23	266	11.99	95.89	1015	0.70	257	36.75	-122.02	13.50
950517	2340	6.94	274	11.92	96.03	1015	0.96	264	36.75	-122.03	13.50
950517	2350	6.97	275	11.90	96.48	1015	0.79	258	36.75	-122.03	13.40
950518	0	7.13	277	11.87	96.38	1015	0.73	260	36.75	-122.04	13.40
950518	10	8.09	271	11.90	94.63	1015	0.70	250	36.75	-122.04	13.30
950518	20	7.75	268	11.92	93.95	1014	0.67	240	36.75	-122.05	13.30
950518	30	8.35	273	11.82	94.02	1014	0.63	257	36.75	-122.05	13.30
950518	40	8.38	272	11.75	94.22	1014	0.63	263	36.75	-122.06	13.20
950518	50	8.58	272	11.79	94.02	1014	0.72	258	36.75	-122.06	13.20
950518	100	8.72	274	11.83	94.00	1014	0.70	258	36.74	-122.07	13.20
950518	110	9.56	272	11.75	93.62	1014	0.66	256	36.74	-122.07	13.10
950518	120	10.48	253	11.75	92.09	1014	0.59	227	36.74	-122.07	13.00
950518	130	10.16	260	11.69	92.07	1014	0.56	247	36.74	-122.08	12.90
950518	140	10.22	276	11.67	92.02	1014	0.77	258	36.74	-122.08	12.90
950518	150	10.69	267	11.57	91.98	1014	0.64	249	36.74	-122.09	12.90
950518	200	9.98	277	11.57	92.07	1014	0.76	257	36.74	-122.09	12.80
950518	210	10.39	276	11.52	91.99	1014	0.78	254	36.74	-122.10	12.90
950518	220	10.35	275	11.55	91.96	1014	0.73	253	36.74	-122.10	13.00

950518	230	10.42	275	11.57	92.02	1014	0.77	258	36.73	-122.11	12.90
950518	240	10.07	282	11.54	91.58	1014	0.70	265	36.73	-122.11	12.90
950518	250	11.01	279	11.52	91.70	1014	0.63	267	36.73	-122.11	12.80
950518	300	11.43	285	11.48	90.80	1014	0.79	270	36.73	-122.12	12.80
950518	310	10.77	284	11.52	91.89	1014	0.77	271	36.73	-122.12	12.90
950518	320	11.74	279	11.51	90.66	1014	0.85	247	36.73	-122.13	12.80
950518	330	10.56	281	11.49	91.20	1014	0.89	250	36.73	-122.14	12.90
950518	340	10.85	283	11.57	91.27	1014	0.94	255	36.73	-122.14	12.90
950518	350	9.81	282	11.48	91.83	1014	0.84	254	36.73	-122.15	12.90
950518	400	9.80	276	11.45	91.86	1014	0.86	248	36.73	-122.15	12.90
950518	410	10.08	284	11.40	91.65	1014	0.90	256	36.73	-122.16	12.90
950518	420	11.11	269	11.42	90.30	1014	0.82	244	36.72	-122.16	12.90
950518	430	10.70	279	11.44	90.43	1015	0.85	252	36.72	-122.17	12.80
950518	440	10.14	272	11.42	90.02	1015	0.85	252	36.72	-122.17	12.70
950518	450	10.04	290	11.45	91.02	1015	0.88	270	36.72	-122.18	12.80
950518	500	10.64	288	11.42	90.00	1015	0.96	268	36.72	-122.19	12.70
950518	510	9.97	289	11.40	89.52	1015	0.95	267	36.72	-122.19	12.70
950518	520	9.34	291	11.43	89.92	1015	0.88	265	36.72	-122.20	12.60
950518	530	8.61	297	11.43	90.50	1015	0.89	265	36.72	-122.20	12.50
950518	540	9.56	298	11.30	89.38	1015	0.84	257	36.72	-122.21	12.60
950518	550	9.32	295	11.27	88.96	1015	0.84	255	36.72	-122.22	12.60
950518	600	8.43	305	11.28	89.43	1015	0.82	258	36.72	-122.22	12.60
950518	610	7.40	298	11.31	90.93	1015	0.81	262	36.72	-122.23	12.70
950518	620	8.22	288	11.26	89.88	1015	0.69	263	36.72	-122.23	12.70
950518	630	7.94	285	11.24	89.07	1015	0.67	253	36.71	-122.24	12.70
950518	640	7.28	297	11.24	90.23	1015	0.73	263	36.71	-122.24	12.70
950518	650	8.03	292	11.23	89.52	1015	0.70	264	36.71	-122.25	12.70
950518	700	8.02	286	11.18	89.08	1015	0.76	253	36.71	-122.25	12.60
950518	710	7.61	289	11.16	89.06	1015	0.75	256	36.71	-122.26	12.70
950518	720	7.52	303	11.13	89.32	1015	0.80	268	36.71	-122.26	12.70
950518	730	8.20	294	11.15	88.99	1015	0.77	258	36.71	-122.27	12.70
950518	740	7.41	295	11.15	89.67	1015	0.84	264	36.71	-122.27	12.70
950518	750	7.73	293	11.14	88.97	1015	0.80	262	36.71	-122.28	12.70
950518	800	7.98	285	11.19	88.96	1015	0.75	264	36.71	-122.28	12.90
950518	810	7.53	297	11.20	88.63	1015	0.74	268	36.71	-122.29	12.90
950518	820	7.19	290	11.21	87.77	1015	0.77	259	36.71	-122.29	13.00
950518	830	7.33	301	11.33	88.28	1015	0.73	268	36.71	-122.30	13.00
950518	840	6.69	285	11.32	88.85	1015	0.64	242	36.71	-122.30	13.00
950518	850	7.46	287	11.33	88.18	1015	0.49	260	36.71	-122.30	13.10
950518	900	7.22	274	11.31	87.96	1015	0.47	256	36.70	-122.31	13.10
950518	910	7.32	285	11.32	88.77	1015	0.67	246	36.70	-122.31	13.10
950518	920	7.25	299	11.30	89.02	1015	0.78	256	36.70	-122.32	13.10
950518	930	7.05	298	11.29	89.35	1015	0.77	253	36.70	-122.32	13.10
950518	940	6.57	280	11.31	89.72	1015	0.70	253	36.70	-122.33	13.20
950518	950	6.43	292	11.26	88.98	1015	0.65	275	36.70	-122.33	13.20
950518	1000	5.92	305	11.30	89.16	1015	0.70	276	36.70	-122.33	13.20
950518	1010	6.49	293	11.31	89.30	1015	0.74	261	36.70	-122.34	13.20
950518	1020	5.82	302	11.33	89.56	1015	0.64	277	36.70	-122.34	13.20
950518	1030	6.71	297	11.25	88.46	1015	0.60	255	36.70	-122.35	13.20
950518	1040	7.79	289	11.30	88.09	1015	0.56	263	36.70	-122.35	13.20
950518	1050	7.03	301	11.27	88.13	1015	0.67	254	36.70	-122.36	13.20
950518	1056	7.64	288	11.31	88.14	1015	0.65	253	36.70	-122.36	-99.00
950518	1100	7.02	309	11.22	87.52	1015	0.67	273	36.70	-122.36	13.10
950518	1110	7.85	305	11.24	88.37	1015	0.79	267	36.70	-122.36	13.20
950518	1120	7.91	303	11.24	87.70	1015	0.66	271	36.70	-122.37	13.20
950518	1130	7.69	305	11.24	88.15	1015	0.58	275	36.70	-122.37	13.20
950518	1140	7.31	306	11.19	87.43	1015	0.65	274	36.70	-122.38	13.10
950518	1150	6.37	317	11.24	88.33	1015	0.71	289	36.70	-122.38	13.10
950518	1200	7.75	313	11.26	87.92	1015	0.58	297	36.70	-122.39	13.20
950518	1210	7.85	304	11.20	87.02	1015	0.57	286	36.70	-122.39	13.10
950518	1220	6.36	331	11.20	87.43	1015	1.06	80	36.70	-122.39	13.10
950518	1230	6.64	345	11.20	87.73	1015	4.02	77	36.70	-122.37	13.20
950518	1240	6.54	334	11.20	88.13	1015	4.57	78	36.71	-122.34	13.10

950518	1250	5.99	321	11.12	87.94	1015	4.57	78	36.71	-122.31	12.90
950518	1300	5.64	334	11.10	88.54	1015	4.59	78	36.72	-122.28	12.60
950518	1310	5.13	317	11.02	88.95	1015	4.60	79	36.72	-122.25	12.60
950518	1320	5.11	334	11.02	89.82	1015	4.52	80	36.73	-122.22	12.60
950518	1330	4.86	342	10.97	89.71	1015	4.52	81	36.73	-122.19	12.60
950518	1340	4.98	335	10.86	89.82	1015	4.48	80	36.73	-122.16	12.50
950518	1350	3.69	338	10.78	90.33	1015	4.52	80	36.74	-122.13	12.50
950518	1400	4.33	336	10.72	91.24	1015	4.50	79	36.74	-122.10	12.60
950518	1410	3.91	346	10.60	93.29	1016	4.55	76	36.75	-122.07	12.50
950518	1420	3.50	332	10.47	93.79	1016	4.72	74	36.75	-122.04	12.30
950518	1430	3.27	325	10.40	93.72	1016	4.72	77	36.76	-122.01	12.50
950518	1440	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	12.50
950518	1450	1.21	4	10.36	92.46	1016	4.89	78	36.77	-121.94	12.50
950518	1500	0.78	275	10.40	93.06	1016	4.85	77	36.78	-121.92	12.60
950518	1510	0.63	238	10.42	93.44	1016	4.97	75	36.78	-121.89	13.20
950518	1520	0.61	147	10.50	93.12	1016	4.95	74	36.79	-121.85	13.60
950518	1530	1.72	166	10.53	92.28	1016	4.85	74	36.80	-121.82	13.70
950518	1540	1.18	142	10.52	92.04	1016	1.68	56	36.80	-121.80	13.30
950518	1550	0.46	90	10.77	92.17	1016	0.32	254	36.81	-121.80	13.10
950518	1600	0.55	127	11.03	90.90	1016	0.24	169	36.80	-121.80	12.50
950518	1610	0.65	141	10.74	90.49	1016	0.20	2	36.80	-121.80	12.50
950518	1620	0.97	167	10.65	90.75	1016	0.41	132	36.80	-121.80	12.90
950518	1630	0.44	168	10.68	90.83	1016	0.41	47	36.80	-121.80	13.10
950518	1640	0.59	168	10.82	90.63	1017	1.89	284	36.81	-121.80	13.20
950518	1650	0.96	147	10.81	90.95	1016	0.43	223	36.81	-121.81	13.90
950518	1700	0.40	168	10.87	91.15	1017	0.14	43	36.81	-121.81	13.40
950518	1710	0.72	208	10.99	90.82	1017	0.29	98	36.81	-121.81	13.90
950518	1720	1.09	169	10.92	91.11	1016	1.90	281	36.81	-121.81	14.00
950518	1730	0.87	174	11.00	91.63	1016	0.70	112	36.81	-121.82	14.00
950518	1740	1.20	166	10.87	91.63	1016	3.78	87	36.80	-121.80	13.80
950518	1750	0.69	201	10.91	92.02	1016	0.95	157	36.81	-121.79	15.70
950518	1800	0.34	214	11.21	91.57	1017	0.01	99	36.80	-121.79	20.20
950518	1810	0.35	68	11.51	89.93	1017	0.02	352	36.80	-121.79	20.40
950518	1820	0.15	165	11.51	89.09	1016	0.01	171	36.80	-121.79	21.30
950518	1830	0.06	33	11.65	88.97	1016	0.01	238	36.80	-121.79	20.70
950518	1840	0.30	168	11.79	88.67	1016	0.00	304	36.80	-121.79	21.60
950518	1850	0.24	217	12.06	88.07	1016	0.02	189	36.80	-121.79	23.30
950518	1900	0.41	356	12.24	87.13	1016	0.01	260	36.80	-121.79	23.40
950518	1910	0.35	104	12.52	86.57	1016	0.01	56	36.80	-121.79	23.20
950518	1920	0.34	36	12.74	84.95	1016	0.01	346	36.80	-121.79	24.50
950518	1930	0.42	236	12.76	84.58	1016	0.03	170	36.80	-121.79	23.80
950518	1940	0.39	85	12.94	83.96	1016	0.02	91	36.80	-121.79	24.80
950518	1950	0.09	6	12.27	85.51	1015	0.01	61	36.80	-121.79	26.60
950518	2000	0.50	245	11.79	88.23	1015	0.01	211	36.80	-121.79	26.60
950518	2010	0.97	228	12.02	87.86	1015	0.01	152	36.80	-121.79	27.90
950518	2020	0.05	63	12.35	87.48	1015	0.00	159	36.80	-121.79	22.70
950518	2030	0.74	119	12.62	85.90	1015	0.01	67	36.80	-121.79	23.30
950518	2040	0.64	290	12.71	85.28	1015	0.03	207	36.80	-121.79	21.10
950518	2050	0.78	77	12.72	84.86	1015	0.01	13	36.80	-121.79	21.00
950518	2100	0.30	281	12.93	83.77	1015	0.01	198	36.80	-121.79	-99.00
950518	2110	0.42	200	13.00	83.81	1015	0.03	52	36.80	-121.79	-99.00
950518	2120	2.82	265	12.56	85.51	1015	1.03	351	36.81	-121.79	-99.00
950518	2130	5.85	246	11.61	88.86	1015	4.49	234	36.80	-121.80	-99.00
950518	2140	5.86	248	11.26	90.18	1015	4.68	252	36.79	-121.83	-99.00
950518	2150	6.31	256	11.23	90.42	1015	4.61	261	36.78	-121.86	-99.00
950518	2200	6.07	259	11.21	89.80	1015	4.56	260	36.78	-121.89	-99.00
950518	2210	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	12.70
950518	2220	6.51	267	11.25	89.02	1015	4.29	256	36.77	-121.95	12.70
950518	2230	5.89	275	11.30	89.89	1015	3.50	254	36.77	-121.97	13.00
950518	2240	5.00	313	11.38	89.17	1015	0.32	307	36.76	-121.98	13.00
950518	2250	5.28	283	11.39	89.27	1015	0.63	278	36.77	-121.99	13.20
950518	2300	5.67	288	11.37	89.13	1015	0.58	276	36.77	-121.99	13.00
950518	2310	5.09	288	11.34	89.42	1015	0.57	275	36.77	-121.99	13.00

950518	2320	5.17	278	11.35	89.70	1015	0.68	268	36.77	-122.00	13.10
950518	2330	5.35	274	11.35	89.48	1015	0.64	269	36.77	-122.00	13.00
950518	2340	5.44	280	11.35	89.71	1015	0.64	277	36.77	-122.01	13.10
950518	2350	4.96	275	11.34	90.02	1015	0.64	275	36.77	-122.01	13.20
950519	0	4.73	277	11.26	90.69	1014	0.76	254	36.77	-122.02	13.10
950519	10	4.82	283	11.18	90.52	1014	0.72	252	36.76	-122.02	13.10
950519	20	4.67	277	11.13	91.13	1014	0.70	262	36.76	-122.03	13.20
950519	30	3.60	286	11.11	91.41	1014	0.74	274	36.76	-122.03	13.10
950519	40	4.24	307	11.10	92.00	1014	0.67	285	36.76	-122.04	13.10
950519	50	4.03	293	11.06	92.18	1014	0.74	292	36.77	-122.04	13.10
950519	100	4.10	299	11.04	92.91	1014	0.74	290	36.77	-122.05	12.90
950519	110	4.27	306	11.06	93.22	1014	0.81	293	36.77	-122.05	12.80
950519	120	3.98	303	11.02	93.52	1014	0.78	291	36.77	-122.06	12.70
950519	130	3.87	295	11.07	93.73	1014	0.90	290	36.77	-122.06	12.70
950519	140	4.04	283	11.10	93.40	1014	0.85	279	36.77	-122.07	13.00
950519	150	3.95	283	11.07	93.68	1014	0.79	270	36.77	-122.07	13.10
950519	200	3.88	272	11.07	93.98	1014	0.75	265	36.77	-122.08	13.10
950519	210	3.83	261	11.08	94.03	1014	0.78	256	36.77	-122.08	13.10
950519	220	3.81	272	11.06	94.47	1014	0.85	258	36.77	-122.09	13.10
950519	230	3.44	265	10.99	95.27	1014	0.89	256	36.77	-122.09	13.10
950519	240	3.52	257	10.91	95.70	1014	0.84	262	36.77	-122.10	13.00
950519	250	3.85	265	10.79	96.01	1014	0.74	252	36.77	-122.10	12.80
950519	300	2.98	276	10.65	96.44	1014	0.77	253	36.77	-122.11	12.70
950519	310	3.24	264	10.69	97.07	1014	0.68	250	36.77	-122.11	12.80
950519	320	3.51	266	10.73	97.38	1014	0.66	253	36.77	-122.12	12.80
950519	330	4.04	272	10.72	97.47	1014	0.70	256	36.76	-122.12	12.80
950519	340	3.76	276	10.68	97.64	1014	0.75	246	36.76	-122.13	12.70
950519	350	4.14	300	10.63	97.88	1014	0.76	254	36.76	-122.13	12.70
950519	400	4.38	295	10.62	98.00	1014	0.70	252	36.76	-122.13	12.70
950519	410	4.28	297	10.62	98.08	1014	0.77	244	36.76	-122.14	12.70
950519	420	4.12	307	10.58	98.62	1014	0.82	247	36.76	-122.14	12.60
950519	430	3.86	317	10.59	98.98	1014	0.67	253	36.76	-122.15	12.60
950519	440	3.89	328	10.55	98.99	1014	0.99	265	36.76	-122.15	12.50
950519	450	3.73	324	10.55	98.50	1014	1.13	261	36.75	-122.16	12.50
950519	500	3.24	328	10.73	98.17	1014	1.11	256	36.75	-122.17	12.60
950519	510	2.58	330	10.91	97.93	1015	1.13	249	36.75	-122.18	12.60
950519	520	3.19	331	10.95	97.56	1015	1.13	247	36.75	-122.18	12.70
950519	530	3.54	324	10.98	97.16	1014	1.10	251	36.75	-122.19	12.70
950519	540	4.10	327	11.03	97.07	1014	1.15	249	36.75	-122.20	12.60
950519	550	4.08	320	11.01	97.18	1014	1.03	245	36.74	-122.20	12.60
950519	600	4.12	324	10.88	97.25	1014	0.73	238	36.74	-122.21	12.60
950519	610	4.67	310	10.79	97.47	1014	0.78	235	36.74	-122.21	12.60
950519	620	4.08	321	10.81	97.83	1014	0.79	239	36.74	-122.22	12.60
950519	630	4.94	314	10.84	97.61	1014	0.77	233	36.73	-122.22	12.60
950519	640	4.74	316	10.94	97.17	1014	0.70	235	36.73	-122.23	12.60
950519	650	4.42	315	10.98	96.98	1014	0.82	223	36.73	-122.23	12.60
950519	700	5.10	315	11.00	96.58	1014	0.76	227	36.73	-122.23	12.60
950519	710	4.81	317	11.10	96.07	1014	0.62	235	36.72	-122.24	12.70
950519	720	3.83	312	11.09	96.18	1014	0.77	223	36.72	-122.24	12.70
950519	730	4.21	325	11.04	96.44	1014	0.67	239	36.72	-122.24	12.70
950519	740	4.12	326	11.03	96.84	1014	0.60	235	36.72	-122.25	12.60
950519	750	4.33	317	10.98	96.76	1014	0.61	232	36.72	-122.25	12.60
950519	800	5.01	321	11.00	96.55	1014	0.64	235	36.71	-122.26	12.60
950519	810	5.86	312	10.97	96.65	1014	0.60	226	36.71	-122.26	12.60
950519	820	5.22	325	11.01	96.01	1014	0.43	243	36.71	-122.26	12.60
950519	830	5.20	327	11.04	95.90	1014	0.72	241	36.71	-122.26	12.60
950519	840	4.90	331	11.05	96.00	1014	0.71	239	36.71	-122.27	12.60
950519	850	3.81	340	11.03	96.19	1014	0.76	245	36.70	-122.27	12.60
950519	900	4.75	304	10.97	95.54	1014	0.70	237	36.70	-122.28	12.60
950519	910	6.34	316	10.99	94.04	1014	0.67	231	36.70	-122.28	12.60
950519	920	6.22	313	10.99	93.96	1013	0.68	229	36.70	-122.28	12.60
950519	930	6.39	298	10.96	93.73	1013	0.76	227	36.69	-122.29	12.60

950519	940	6.19	295	10.95	93.70	1013	0.69	234	36.69	-122.29	12.60
950519	950	6.42	282	10.93	93.88	1013	0.67	225	36.69	-122.30	12.50
950519	1000	6.36	293	10.79	93.94	1013	0.73	236	36.69	-122.30	12.40
950519	1010	6.29	310	10.74	93.99	1013	0.81	253	36.69	-122.30	12.50
950519	1020	6.31	291	10.72	94.00	1013	0.63	244	36.68	-122.31	12.50
950519	1030	5.62	288	10.72	94.00	1013	0.35	243	36.68	-122.31	12.50
950519	1040	5.97	315	10.67	93.99	1013	0.64	274	36.68	-122.32	12.50
950519	1050	6.25	311	10.58	94.00	1013	0.76	269	36.68	-122.32	12.50
950519	1100	6.00	312	10.53	94.00	1013	0.71	273	36.68	-122.32	12.50
950519	1110	5.87	317	10.49	94.20	1013	0.70	269	36.68	-122.33	12.50
950519	1120	6.37	309	10.45	94.12	1013	0.68	267	36.68	-122.33	12.40
950519	1130	6.00	308	10.42	94.43	1013	0.66	268	36.68	-122.34	12.40
950519	1140	5.78	301	10.40	94.51	1013	0.65	268	36.68	-122.34	12.50
950519	1150	6.67	307	10.41	95.05	1013	0.54	286	36.68	-122.35	12.60
950519	1200	6.46	307	10.32	94.90	1013	0.60	287	36.68	-122.35	12.60
950519	1210	6.26	308	10.35	95.15	1013	0.56	293	36.69	-122.35	12.60
950519	1220	6.33	301	10.34	95.03	1013	0.62	281	36.69	-122.36	12.70
950519	1230	6.61	305	10.35	94.93	1013	0.59	292	36.69	-122.36	12.60
950519	1240	6.45	298	10.28	94.40	1013	0.60	283	36.69	-122.36	12.60
950519	1250	5.35	342	10.30	94.48	1013	3.63	78	36.69	-122.36	12.60
950519	1300	5.67	349	10.32	94.84	1013	4.57	78	36.70	-122.33	12.40
950519	1310	5.53	350	10.27	95.56	1013	4.58	76	36.70	-122.30	12.40
950519	1320	4.84	355	10.19	95.79	1013	4.70	74	36.71	-122.27	12.40
950519	1330	4.49	350	10.10	96.07	1013	4.61	74	36.71	-122.24	12.40
950519	1340	4.22	354	10.03	96.74	1013	4.77	75	36.72	-122.21	12.40
950519	1350	4.30	339	9.99	97.65	1013	4.64	75	36.73	-122.18	12.50
950519	1400	3.95	341	10.01	98.03	1013	4.66	77	36.73	-122.15	12.60
950519	1410	3.64	348	9.93	98.92	1013	4.79	78	36.74	-122.12	12.70
950519	1420	3.24	358	9.85	99.88	1013	4.84	75	36.74	-122.08	12.80
950519	1430	2.62	7	9.64	100.14	1013	4.80	75	36.75	-122.05	12.60
950519	1440	0.72	9	9.53	100.49	1013	4.84	73	36.76	-122.02	12.50
950519	1450	0.89	288	9.57	101.10	1013	4.78	74	36.77	-121.99	12.40
950519	1500	0.36	67	9.79	101.52	1013	4.72	74	36.77	-121.96	12.70
950519	1510	0.86	27	9.85	101.87	1013	4.70	76	36.78	-121.93	12.70
950519	1520	0.55	17	9.95	101.99	1013	4.83	77	36.78	-121.90	12.80
950519	1530	0.86	94	10.05	102.00	1013	4.95	78	36.79	-121.86	13.40
950519	1540	0.60	107	10.02	102.00	1013	4.80	79	36.80	-121.83	13.20
950519	1550	0.35	247	10.04	102.00	1013	2.94	60	36.80	-121.80	13.30
950519	1600	0.40	140	10.13	102.00	1014	0.11	9	36.81	-121.80	13.00
950519	1610	1.05	314	10.17	102.00	1014	0.43	162	36.80	-121.80	13.10
950519	1620	0.93	1	10.31	102.03	1013	0.37	146	36.80	-121.80	14.30
950519	1630	1.40	298	10.32	102.01	1013	1.32	307	36.80	-121.80	14.20
950519	1640	0.66	281	10.33	102.02	1013	0.78	282	36.81	-121.81	13.40
950519	1650	0.42	72	10.72	102.02	1013	0.06	298	36.81	-121.81	13.40
950519	1700	0.39	93	10.58	102.01	1013	0.13	256	36.81	-121.81	13.10
950519	1710	0.62	196	10.45	102.00	1013	0.90	205	36.80	-121.81	13.50
950519	1720	1.55	223	10.44	102.00	1013	1.00	27	36.80	-121.81	13.60
950519	1730	2.03	248	10.53	102.00	1013	0.40	308	36.81	-121.81	13.40
950519	1740	3.24	259	10.43	102.00	1013	0.25	289	36.81	-121.81	13.50
950519	1750	2.41	263	10.37	102.00	1013	0.34	176	36.81	-121.81	13.50
950519	1800	1.96	262	10.44	102.00	1013	1.34	117	36.80	-121.81	13.70
950519	1810	1.41	221	10.49	102.00	1013	0.49	134	36.80	-121.80	13.40
950519	1820	1.37	263	10.51	102.00	1013	0.89	50	36.80	-121.80	13.40
950519	1830	2.15	239	10.44	102.00	1013	0.34	146	36.80	-121.80	12.70
950519	1840	2.37	287	10.45	102.01	1013	0.25	320	36.80	-121.80	13.40
950519	1850	2.25	269	10.40	102.00	1013	1.30	66	36.80	-121.80	13.60
950519	1900	2.70	281	10.46	102.00	1013	0.96	155	36.81	-121.79	15.90
950519	1910	0.87	255	10.54	102.00	1013	0.85	18	36.80	-121.79	16.70
950519	1920	3.36	280	10.41	101.59	1013	2.58	243	36.81	-121.79	14.00
950519	1930	3.46	265	10.27	100.93	1013	4.47	255	36.80	-121.82	14.30
950519	1940	3.80	271	10.26	100.22	1013	4.48	253	36.79	-121.84	13.90
950519	1950	4.44	270	10.27	99.48	1013	4.52	251	36.78	-121.87	13.20
950519	2000	4.41	274	10.25	98.52	1013	4.51	253	36.78	-121.90	13.10

950519	2010	4.49	284	10.39	97.88	1013	4.56	252	36.77	-121.93	13.40
950519	2020	5.16	288	10.63	96.90	1013	4.57	256	36.76	-121.96	13.20
950519	2030	5.05	294	10.76	95.92	1013	2.32	260	36.76	-121.99	12.90
950519	2040	5.89	281	10.88	95.68	1012	0.99	248	36.76	-121.99	12.80
950519	2050	5.88	278	10.97	95.27	1012	0.91	243	36.75	-122.00	12.70
950519	2100	6.10	285	10.97	94.73	1012	0.92	246	36.75	-122.01	12.60
950519	2110	6.22	280	10.99	94.28	1012	0.80	250	36.75	-122.01	12.70
950519	2120	6.13	275	11.01	94.63	1012	0.72	247	36.75	-122.02	12.80
950519	2130	6.03	277	11.06	94.49	1012	0.67	246	36.75	-122.02	12.90
950519	2140	6.02	276	11.03	94.27	1012	0.65	247	36.75	-122.02	12.90
950519	2150	5.82	276	11.04	95.13	1012	0.57	255	36.74	-122.03	13.00
950519	2200	6.62	270	11.13	95.77	1012	0.53	243	36.74	-122.03	13.10
950519	2210	6.55	272	11.07	95.79	1012	0.52	257	36.74	-122.03	13.20
950519	2220	6.65	260	11.08	95.67	1012	0.42	241	36.74	-122.04	13.30
950519	2230	6.44	261	11.06	95.45	1012	0.45	243	36.74	-122.04	13.30
950519	2240	7.47	266	11.10	95.67	1012	0.53	255	36.74	-122.04	13.40
950519	2250	7.60	280	11.11	95.41	1012	0.76	263	36.74	-122.05	13.20
950519	2300	7.56	279	11.09	95.66	1012	0.77	264	36.74	-122.05	13.30
950519	2310	8.01	284	11.08	95.25	1012	0.64	267	36.74	-122.06	13.20
950519	2320	7.89	280	11.07	95.03	1012	0.62	264	36.74	-122.06	13.30
950519	2330	7.54	279	11.09	94.90	1012	0.62	265	36.74	-122.07	13.30
950519	2340	7.25	284	11.08	94.58	1012	0.69	268	36.74	-122.07	13.10
950519	2350	7.53	283	11.10	94.21	1012	0.56	268	36.74	-122.07	13.20
950520	0	7.15	293	11.14	95.02	1012	0.62	279	36.74	-122.08	13.30
950520	10	7.53	287	11.15	94.57	1012	0.59	276	36.74	-122.08	13.40
950520	20	8.11	276	11.13	94.01	1012	0.64	264	36.74	-122.09	13.20
950520	30	7.51	287	11.13	94.30	1012	0.67	275	36.74	-122.09	13.20
950520	40	7.66	275	11.08	94.63	1012	0.67	255	36.74	-122.09	13.10
950520	50	7.73	272	10.88	95.48	1012	0.68	253	36.74	-122.10	13.20
950520	100	7.58	271	10.92	95.87	1012	0.67	253	36.74	-122.10	13.10
950520	110	6.92	268	10.93	95.93	1012	0.67	246	36.73	-122.11	13.10
950520	120	7.00	259	10.85	95.99	1012	0.66	246	36.73	-122.11	13.00
950520	130	6.88	259	10.80	96.27	1012	0.75	250	36.73	-122.12	13.10
950520	140	6.73	265	10.69	96.23	1012	0.67	255	36.73	-122.12	13.10
950520	150	6.15	274	10.71	96.96	1012	0.73	253	36.73	-122.12	13.10
950520	200	6.46	273	10.73	97.13	1012	0.72	259	36.73	-122.13	13.10
950520	210	6.41	286	10.62	97.19	1012	0.78	259	36.73	-122.13	12.90
950520	220	7.07	274	10.61	97.31	1012	0.75	261	36.73	-122.14	12.90
950520	230	6.17	279	10.46	97.14	1012	0.75	258	36.73	-122.14	12.90
950520	240	6.06	286	10.53	97.32	1012	0.78	265	36.73	-122.15	12.90
950520	250	6.60	270	10.52	96.80	1012	0.77	258	36.72	-122.16	12.80
950520	300	5.92	270	10.52	96.81	1012	0.84	250	36.72	-122.16	12.70
950520	310	6.20	281	10.53	96.71	1012	0.90	256	36.72	-122.17	12.70
950520	320	6.53	292	10.43	96.10	1012	0.92	260	36.72	-122.17	12.70
950520	330	6.06	300	10.32	95.90	1012	0.84	261	36.72	-122.18	12.60
950520	340	5.32	298	10.32	95.91	1012	0.85	264	36.72	-122.18	12.50
950520	350	5.54	285	10.42	96.05	1012	0.78	268	36.72	-122.19	12.50
950520	400	5.73	296	10.28	95.86	1012	0.77	264	36.72	-122.19	12.60
950520	410	5.50	303	10.32	95.98	1013	0.79	262	36.72	-122.20	12.60
950520	420	5.61	301	10.32	95.99	1013	0.80	261	36.72	-122.21	12.60
950520	430	4.89	294	10.39	96.02	1013	0.70	262	36.72	-122.21	12.50
950520	440	4.52	283	10.37	95.65	1013	0.79	265	36.72	-122.22	12.50
950520	450	4.32	299	10.40	95.16	1013	0.71	277	36.72	-122.22	12.50
950520	500	4.77	303	10.41	95.10	1013	0.80	269	36.72	-122.23	12.50
950520	510	4.16	297	10.48	95.73	1013	0.84	255	36.72	-122.23	12.50
950520	520	5.00	316	10.52	95.61	1013	0.72	269	36.72	-122.24	12.50
950520	530	4.56	306	10.34	94.25	1013	0.85	270	36.71	-122.24	12.50
950520	540	3.72	312	10.27	94.07	1013	0.86	267	36.71	-122.25	12.60
950520	550	4.34	320	10.36	94.29	1013	1.01	260	36.71	-122.25	12.60
950520	600	4.35	318	10.44	94.04	1013	1.29	259	36.71	-122.26	12.60
950520	610	4.88	312	10.46	93.97	1013	1.16	264	36.71	-122.27	12.60
950520	620	4.58	317	10.36	92.77	1013	1.08	263	36.71	-122.28	12.40

950520	630	3.61	320	10.32	93.23	1013	1.05	266	36.71	-122.28	12.40
950520	640	3.27	313	10.33	93.47	1013	0.85	267	36.71	-122.29	12.40
950520	650	4.55	322	10.36	93.98	1013	0.83	262	36.71	-122.30	12.40
950520	700	4.09	325	10.19	93.73	1013	0.74	257	36.71	-122.30	12.40
950520	710	3.47	335	10.18	93.96	1013	0.74	266	36.71	-122.31	12.50
950520	720	3.51	314	10.23	94.00	1013	0.79	263	36.71	-122.31	12.70
950520	730	3.37	316	10.33	94.00	1013	0.82	262	36.71	-122.32	12.80
950520	740	3.65	331	10.30	93.68	1013	0.78	260	36.71	-122.32	12.60
950520	750	3.54	326	10.19	93.05	1013	0.84	259	36.70	-122.33	12.50
950520	800	2.61	310	10.03	92.62	1013	0.78	253	36.70	-122.33	12.40
950520	810	3.31	331	10.07	93.74	1013	0.77	270	36.70	-122.34	12.40
950520	820	3.08	320	10.13	93.57	1013	0.83	261	36.70	-122.34	12.40
950520	830	3.00	328	10.15	93.37	1012	0.85	254	36.70	-122.35	12.50
950520	840	3.72	327	10.25	93.18	1013	0.85	256	36.70	-122.35	12.50
950520	850	4.24	318	10.21	92.88	1012	0.86	251	36.70	-122.36	12.50
950520	900	3.36	314	10.22	93.18	1012	0.80	252	36.70	-122.36	12.60
950520	910	3.77	297	10.28	93.02	1012	0.82	258	36.70	-122.37	12.60
950520	920	3.72	300	10.24	92.28	1012	0.84	264	36.70	-122.38	12.60
950520	930	3.59	299	10.21	92.06	1012	0.76	262	36.69	-122.38	12.60
950520	940	2.86	317	10.21	92.53	1012	0.84	263	36.69	-122.39	12.60
950520	950	4.23	330	10.29	93.06	1012	0.66	292	36.69	-122.39	12.70
950520	1000	3.99	334	10.22	92.07	1012	0.67	308	36.70	-122.40	12.70
950520	1010	4.03	325	10.20	92.02	1012	0.76	305	36.70	-122.40	12.60
950520	1020	3.91	334	10.20	92.04	1012	0.78	308	36.70	-122.40	12.70
950520	1030	3.59	318	10.17	92.03	1012	0.69	315	36.70	-122.41	12.70
950520	1040	3.58	313	10.21	92.03	1012	0.65	308	36.71	-122.41	12.70
950520	1050	3.47	324	10.24	91.98	1012	0.68	309	36.71	-122.41	12.70
950520	1100	3.66	326	10.20	90.88	1012	0.65	313	36.71	-122.42	12.70
950520	1110	3.90	320	10.25	90.83	1012	0.63	316	36.71	-122.42	12.80
950520	1120	3.94	328	10.29	90.43	1012	0.61	320	36.72	-122.42	12.80
950520	1130	3.95	329	10.44	90.72	1012	0.72	313	36.72	-122.43	12.80
950520	1140	3.75	334	10.52	90.93	1012	0.67	318	36.72	-122.43	12.80
950520	1150	4.22	326	10.64	90.90	1012	0.72	312	36.72	-122.43	12.90
950520	1200	4.29	314	10.66	89.64	1012	0.72	321	36.73	-122.44	12.90
950520	1210	4.11	321	10.79	90.09	1013	0.76	320	36.73	-122.44	13.00
950520	1220	4.33	311	10.85	89.43	1012	0.73	320	36.73	-122.44	12.90
950520	1230	4.36	314	10.92	89.26	1013	0.69	322	36.74	-122.44	13.00
950520	1240	4.36	314	11.02	89.17	1013	0.64	303	36.74	-122.45	13.00
950520	1250	3.92	322	11.01	89.07	1013	0.68	302	36.74	-122.45	13.00
950520	1300	4.83	326	11.04	89.02	1013	0.67	308	36.74	-122.45	13.00
950520	1310	4.37	314	11.10	88.59	1013	0.17	334	36.75	-122.46	13.00
950520	1320	4.53	315	11.09	88.84	1013	3.13	135	36.74	-122.45	13.10
950520	1330	4.53	328	11.27	88.15	1013	3.13	133	36.73	-122.43	13.10
950520	1340	5.07	324	11.73	86.98	1013	3.11	133	36.72	-122.42	13.10
950520	1350	4.18	317	11.64	86.77	1013	3.13	131	36.70	-122.40	13.00
950520	1400	4.16	313	11.58	86.33	1014	2.86	128	36.69	-122.39	12.90
950520	1410	4.81	319	11.27	86.31	1013	0.73	311	36.69	-122.38	12.80
950520	1420	3.77	321	11.15	86.10	1014	0.75	313	36.69	-122.39	12.80
950520	1430	4.70	325	11.15	87.77	1014	0.70	319	36.70	-122.39	12.90
950520	1440	4.50	319	11.13	86.74	1014	0.54	316	36.70	-122.39	12.90
950520	1450	3.79	319	11.12	85.65	1014	0.48	310	36.70	-122.40	13.00
950520	1500	3.52	320	11.18	86.19	1014	0.48	312	36.70	-122.40	12.90
950520	1510	4.24	326	11.12	86.63	1014	0.42	319	36.70	-122.40	12.90
950520	1520	2.89	331	11.08	85.33	1014	0.42	319	36.71	-122.40	12.90
950520	1530	3.66	326	11.12	85.92	1014	0.42	316	36.71	-122.40	12.90
950520	1540	2.96	325	11.09	85.83	1014	0.43	318	36.71	-122.41	13.00
950520	1550	2.77	338	11.12	86.63	1014	0.37	321	36.71	-122.41	13.10
950520	1600	2.98	338	11.10	86.77	1014	0.38	312	36.71	-122.41	13.00
950520	1610	2.91	340	11.09	86.06	1014	0.48	320	36.71	-122.41	13.00
950520	1620	2.66	332	11.12	85.83	1014	0.41	332	36.72	-122.41	13.20
950520	1630	2.25	334	11.13	84.84	1014	0.37	338	36.72	-122.41	13.30
950520	1640	2.19	344	11.15	85.86	1014	0.37	342	36.72	-122.41	13.30
950520	1650	2.39	354	11.12	85.90	1014	0.35	340	36.72	-122.42	13.20

950520	1700	2.63	347	11.16	85.91	1014	0.33	327	36.72	-122.42	13.20
950520	1710	2.67	349	11.15	85.38	1014	0.35	341	36.72	-122.42	13.30
950520	1720	2.26	356	11.19	84.31	1015	0.33	347	36.73	-122.42	13.30
950520	1730	1.96	343	11.24	85.13	1015	0.20	325	36.73	-122.42	13.40
950520	1740	1.87	25	11.19	87.50	1015	0.24	335	36.73	-122.42	13.20
950520	1750	1.43	47	11.16	88.78	1015	0.43	354	36.73	-122.42	13.20
950520	1800	1.02	2	11.16	88.92	1015	1.34	128	36.73	-122.42	13.40
950520	1810	1.21	2	11.18	88.28	1015	3.23	138	36.72	-122.40	13.50
950520	1820	0.91	29	11.21	88.71	1015	3.27	139	36.71	-122.39	13.50
950520	1830	1.12	56	11.17	89.92	1015	0.03	282	36.70	-122.38	13.50
950520	1840	1.27	73	11.28	89.27	1015	0.49	321	36.70	-122.38	13.70
950520	1850	0.48	114	11.42	89.09	1015	0.48	330	36.70	-122.39	13.80
950520	1900	0.51	126	11.70	88.64	1015	0.54	328	36.71	-122.39	13.90
950520	1910	0.52	145	12.03	88.07	1015	0.51	328	36.71	-122.39	14.10
950520	1920	0.53	129	12.26	86.63	1015	0.43	333	36.71	-122.39	14.00
950520	1930	0.65	131	12.39	85.99	1015	0.43	329	36.71	-122.39	13.70
950520	1940	0.53	148	12.62	85.62	1015	0.47	334	36.71	-122.39	13.80
950520	1950	0.45	124	12.73	83.88	1015	0.44	338	36.72	-122.40	13.80
950520	2000	0.46	152	12.85	83.57	1015	0.46	332	36.72	-122.40	14.00
950520	2010	0.42	137	13.21	82.54	1015	0.42	320	36.72	-122.40	14.10
950520	2020	0.38	150	13.43	81.47	1015	0.40	326	36.72	-122.40	14.50
950520	2030	0.74	231	13.42	80.29	1015	0.37	325	36.72	-122.40	14.70
950520	2040	1.39	252	12.96	80.57	1015	0.41	326	36.73	-122.40	14.40
950520	2050	2.21	289	12.49	82.26	1015	0.35	319	36.73	-122.40	14.30
950520	2100	2.27	272	12.22	83.00	1015	0.33	309	36.73	-122.41	14.10
950520	2110	2.65	274	12.14	83.39	1015	0.30	307	36.73	-122.41	14.40
950520	2120	2.85	271	12.09	83.82	1015	0.33	289	36.73	-122.41	14.10
950520	2130	3.37	272	12.09	84.31	1015	0.32	288	36.73	-122.41	13.90
950520	2140	3.75	265	12.08	84.56	1015	0.35	278	36.73	-122.41	13.90
950520	2150	3.65	281	12.10	85.16	1015	0.34	293	36.73	-122.42	13.80
950520	2200	3.41	274	12.12	85.38	1015	0.40	286	36.73	-122.42	13.80
950520	2210	2.93	280	12.17	85.91	1015	0.41	295	36.73	-122.42	14.00
950520	2220	3.30	282	12.23	85.01	1015	0.37	286	36.73	-122.42	14.00
950520	2230	3.28	277	12.28	84.27	1015	0.36	284	36.73	-122.43	14.00
950520	2240	3.61	295	12.31	84.20	1015	0.30	294	36.73	-122.43	14.10
950520	2250	3.15	274	12.27	84.38	1014	0.30	279	36.73	-122.43	13.90
950520	2300	3.37	292	12.28	84.65	1014	0.32	289	36.74	-122.43	13.80
950520	2310	3.39	298	12.23	84.73	1014	0.96	143	36.74	-122.43	13.90
950520	2320	3.57	302	12.34	84.67	1014	3.29	139	36.73	-122.42	14.00
950520	2330	3.58	308	12.44	84.22	1014	3.17	134	36.71	-122.41	14.00
950520	2340	3.28	309	12.66	84.16	1014	3.22	129	36.70	-122.39	14.20
950520	2350	3.29	320	12.71	83.59	1014	0.53	103	36.69	-122.38	14.00
950521	0	3.47	315	12.43	85.12	1014	0.33	313	36.70	-122.38	13.90
950521	10	3.31	308	12.35	84.60	1014	0.32	301	36.70	-122.38	14.10
950521	20	3.91	293	12.30	85.43	1014	0.36	292	36.70	-122.38	13.90
950521	30	3.27	281	12.28	84.64	1014	0.39	284	36.70	-122.39	13.80
950521	40	3.88	291	12.29	82.67	1014	0.39	287	36.70	-122.39	14.00
950521	50	3.96	279	12.32	81.47	1014	0.43	284	36.70	-122.39	14.20
950521	100	4.41	286	12.35	80.32	1014	0.37	290	36.70	-122.39	14.10
950521	110	4.57	279	12.34	80.58	1014	0.28	293	36.70	-122.40	14.00
950521	120	4.32	279	12.34	79.82	1014	0.29	293	36.70	-122.40	14.10
950521	130	4.50	285	12.36	80.25	1014	0.29	294	36.70	-122.40	13.90
950521	140	4.39	278	12.30	79.25	1014	0.30	285	36.70	-122.40	13.80
950521	150	4.93	280	12.27	79.77	1014	0.30	278	36.70	-122.40	13.80
950521	200	5.13	270	12.27	79.61	1014	0.25	284	36.70	-122.41	13.70
950521	210	4.92	269	12.32	79.98	1014	0.33	274	36.70	-122.41	13.60
950521	220	3.66	288	12.35	80.33	1014	0.42	282	36.70	-122.41	13.70
950521	230	4.25	287	12.33	80.93	1014	0.34	278	36.70	-122.41	13.70
950521	240	4.12	279	12.29	80.52	1014	0.36	281	36.70	-122.41	13.70
950521	250	4.17	300	12.31	81.98	1014	0.37	297	36.70	-122.42	13.70
950521	300	5.37	296	12.25	80.63	1014	0.19	294	36.71	-122.42	13.60
950521	310	4.60	295	12.21	79.63	1014	0.41	298	36.71	-122.42	13.50

950521	320	5.14	296	12.22	79.62	1014	0.71	299	36.71	-122.42	13.60
950521	330	4.65	308	12.20	79.75	1014	0.75	292	36.71	-122.43	13.70
950521	340	4.72	298	12.22	80.34	1014	0.70	301	36.71	-122.43	13.70
950521	350	6.13	301	12.22	80.02	1014	0.62	303	36.71	-122.44	13.70
950521	400	5.46	301	12.16	78.68	1014	0.70	296	36.71	-122.44	13.60
950521	410	5.66	303	12.23	80.22	1014	0.72	300	36.72	-122.45	13.60
950521	420	5.21	313	12.25	79.44	1014	0.74	297	36.72	-122.45	13.60
950521	430	4.72	306	12.33	80.38	1015	0.82	299	36.72	-122.45	13.70
950521	440	4.12	311	12.34	81.17	1015	0.32	315	36.72	-122.46	13.60
950521	450	5.50	331	12.36	80.99	1015	3.13	114	36.72	-122.45	13.60
950521	500	5.81	333	12.27	78.94	1015	3.09	114	36.71	-122.43	13.60
950521	510	4.98	329	12.19	77.91	1015	3.22	110	36.71	-122.41	13.40
950521	520	3.94	326	12.19	77.93	1015	2.72	95	36.70	-122.39	13.30
950521	530	4.83	316	12.20	79.21	1015	0.67	309	36.70	-122.38	13.20
950521	540	4.72	315	12.23	79.57	1015	0.60	313	36.70	-122.39	13.30
950521	550	5.40	321	12.25	80.58	1015	0.60	327	36.71	-122.39	13.30
950521	600	5.31	322	12.20	79.48	1015	0.55	326	36.71	-122.39	13.30
950521	610	4.97	323	12.19	77.81	1015	0.53	320	36.71	-122.39	13.30
950521	620	4.36	321	12.25	78.70	1015	0.55	308	36.71	-122.40	13.30
950521	630	4.48	319	12.27	80.16	1015	0.61	309	36.72	-122.40	13.30
950521	640	5.65	322	12.21	79.90	1015	0.56	319	36.72	-122.40	13.30
950521	650	4.15	322	12.24	78.02	1015	0.60	321	36.72	-122.40	13.30
950521	700	5.40	319	12.20	79.73	1015	0.57	304	36.72	-122.41	13.40
950521	710	4.80	325	12.17	78.39	1015	0.53	312	36.72	-122.41	13.40
950521	720	4.84	330	12.21	79.23	1015	0.56	308	36.73	-122.41	13.40
950521	730	4.74	341	12.19	79.23	1015	0.60	302	36.73	-122.42	13.40
950521	740	3.64	347	12.16	80.33	1015	0.61	314	36.73	-122.42	13.40
950521	750	3.45	346	12.18	79.79	1015	0.68	336	36.73	-122.42	13.40
950521	800	3.10	352	12.19	80.26	1015	0.76	337	36.74	-122.42	13.40
950521	810	3.31	350	12.17	80.23	1015	0.71	341	36.74	-122.42	13.40
950521	820	2.97	349	12.22	81.43	1015	0.70	340	36.74	-122.43	13.40
950521	830	2.88	338	12.14	81.81	1015	0.76	336	36.75	-122.43	13.40
950521	840	3.66	337	12.17	82.93	1015	0.79	331	36.75	-122.43	13.30
950521	850	4.43	338	12.09	80.86	1015	0.75	327	36.75	-122.43	13.30
950521	900	4.37	321	12.12	77.17	1015	0.75	336	36.76	-122.44	13.30
950521	910	3.31	341	12.11	77.32	1015	0.71	324	36.76	-122.44	13.30
950521	920	3.96	326	12.08	77.53	1014	0.70	323	36.76	-122.44	13.30
950521	930	3.84	329	12.08	78.75	1014	0.72	315	36.77	-122.44	13.30
950521	940	3.66	336	11.98	78.29	1014	0.57	153	36.77	-122.45	13.30
950521	950	3.13	334	11.98	78.56	1014	3.00	145	36.76	-122.44	13.40
950521	1000	3.52	335	11.99	78.79	1014	3.12	142	36.75	-122.43	13.40
950521	1010	3.18	329	11.93	79.03	1014	3.14	148	36.73	-122.41	13.40
950521	1020	3.77	325	11.97	78.57	1014	3.13	148	36.72	-122.40	13.40
950521	1030	3.18	319	11.95	78.34	1014	2.85	144	36.70	-122.39	13.30
950521	1040	4.22	326	12.02	78.84	1014	0.63	303	36.70	-122.39	13.20
950521	1050	5.68	315	11.96	80.66	1014	0.61	300	36.70	-122.39	13.20
950521	1100	6.32	311	11.93	79.94	1014	0.57	321	36.70	-122.40	13.30
950521	1110	5.68	303	11.93	78.05	1014	3.05	84	36.71	-122.39	13.30
950521	1120	5.43	298	11.84	77.96	1014	3.16	87	36.71	-122.37	13.30
950521	1130	3.57	316	11.79	77.13	1014	3.10	82	36.71	-122.34	13.20
950521	1140	4.07	309	11.72	77.28	1014	3.05	79	36.71	-122.32	13.00
950521	1150	3.62	311	11.69	77.93	1014	3.27	80	36.71	-122.30	12.80
950521	1200	4.33	316	11.62	78.37	1014	4.80	78	36.72	-122.28	12.90
950521	1210	4.44	300	11.65	78.50	1014	4.83	75	36.72	-122.24	13.00
950521	1220	4.08	307	11.70	80.00	1014	4.85	77	36.73	-122.21	13.00
950521	1230	3.15	320	11.70	81.67	1014	4.97	79	36.73	-122.18	13.00
950521	1240	3.40	319	11.63	80.26	1014	5.04	80	36.74	-122.15	12.90
950521	1250	2.68	344	11.67	81.02	1014	4.90	79	36.74	-122.11	13.00
950521	1300	2.80	336	11.59	81.42	1014	4.88	77	36.75	-122.08	13.20
950521	1310	2.98	334	11.61	81.19	1014	4.79	74	36.76	-122.05	13.20
950521	1320	3.49	342	11.61	81.16	1014	4.71	74	36.76	-122.02	13.10
950521	1330	3.17	338	11.58	81.13	1014	4.72	77	36.77	-121.99	13.10
950521	1340	2.37	342	11.49	81.28	1014	4.72	78	36.77	-121.96	13.20

950521	1350	2.01	340	11.44	80.73	1014	4.73	79	36.78	-121.93	13.40
950521	1400	1.87	325	11.42	80.13	1014	4.68	77	36.78	-121.90	13.90
950521	1410	2.45	325	11.44	80.01	1014	4.69	79	36.79	-121.87	13.90
950521	1420	2.63	320	11.43	79.76	1014	4.66	78	36.79	-121.83	13.50
950521	1430	2.95	309	11.47	78.90	1014	4.52	66	36.80	-121.80	13.40
950521	1440	2.52	301	11.45	79.27	1014	0.90	128	36.81	-121.79	13.60
950521	1450	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.90
950521	1500	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.90
950521	1510	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.90
950521	1520	0.32	309	11.63	78.55	1015	0.01	214	36.80	-121.79	14.20
950521	1530	0.23	281	11.59	78.06	1015	0.01	111	36.80	-121.79	14.40
950521	1540	0.69	91	11.66	77.85	1015	0.01	342	36.80	-121.79	14.80
950521	1550	0.40	284	11.75	77.99	1015	0.00	176	36.80	-121.79	14.60
950521	1600	0.32	215	11.85	78.01	1015	0.95	14	36.80	-121.79	14.10
950521	1610	1.55	259	11.69	78.50	1015	4.02	245	36.80	-121.80	13.80
950521	1620	2.08	256	11.60	79.59	1015	4.85	253	36.79	-121.83	13.20
950521	1630	2.99	255	11.70	80.55	1015	4.62	257	36.79	-121.86	13.70
950521	1640	2.71	256	11.69	82.11	1015	4.65	257	36.78	-121.89	13.90
950521	1650	2.58	262	11.71	84.40	1015	4.73	257	36.78	-121.92	13.70
950521	1700	3.16	260	11.73	85.93	1015	4.63	255	36.77	-121.95	13.10
950521	1710	3.12	272	11.65	86.29	1015	4.56	251	36.76	-121.98	13.10
950521	1720	2.78	288	11.53	85.92	1015	2.34	225	36.75	-122.00	13.10
950521	1730	2.52	304	11.65	84.91	1015	0.40	289	36.75	-122.00	13.20
950521	1740	3.09	286	11.63	84.22	1015	0.65	284	36.75	-122.01	13.30
950521	1750	2.87	289	11.65	85.22	1016	0.61	286	36.75	-122.01	13.30
950521	1800	3.60	293	11.69	84.87	1016	0.59	285	36.75	-122.02	13.30
950521	1810	3.73	305	11.77	85.55	1016	0.56	283	36.75	-122.02	13.30
950521	1820	3.28	303	11.78	85.90	1016	0.61	283	36.75	-122.02	13.30
950521	1830	3.18	297	11.81	85.76	1016	0.57	285	36.76	-122.03	13.30
950521	1840	2.89	296	11.91	85.88	1016	0.58	285	36.76	-122.03	13.40
950521	1850	2.84	286	11.95	84.89	1016	0.60	284	36.76	-122.03	13.40
950521	1900	2.84	286	12.00	83.53	1016	0.60	284	36.76	-122.04	13.40
950521	1910	3.02	300	12.04	82.73	1016	0.57	290	36.76	-122.04	13.30
950521	1920	3.09	296	12.06	83.04	1016	0.53	288	36.76	-122.05	13.40
950521	1930	2.28	301	12.09	83.48	1016	0.59	291	36.76	-122.05	13.40
950521	1940	3.24	283	12.11	83.26	1016	0.61	294	36.76	-122.05	13.50
950521	1950	3.67	274	12.07	85.66	1016	0.63	297	36.76	-122.06	13.50
950521	2000	3.35	284	12.02	85.94	1016	0.63	280	36.76	-122.06	13.60
950521	2010	2.92	278	12.26	86.17	1016	2.31	96	36.76	-122.06	13.60
950521	2020	3.48	262	12.42	84.32	1016	2.77	111	36.76	-122.04	13.40
950521	2030	3.36	254	12.28	85.27	1015	2.70	111	36.76	-122.02	13.30
950521	2040	2.87	260	12.12	86.21	1015	1.62	112	36.75	-122.00	13.30
950521	2050	3.32	275	12.04	85.70	1015	0.51	292	36.75	-122.00	13.30
950521	2100	3.15	271	12.02	84.96	1015	0.59	286	36.75	-122.01	13.30
950521	2110	3.12	283	12.06	84.93	1015	0.55	294	36.75	-122.01	13.40
950521	2120	3.33	285	12.07	84.38	1015	0.51	281	36.75	-122.01	13.40
950521	2130	2.53	280	12.19	84.47	1015	0.76	272	36.75	-122.02	13.40
950521	2140	2.70	265	12.24	85.13	1015	1.97	68	36.75	-122.02	13.50
950521	2150	4.29	257	12.55	84.49	1015	4.59	77	36.76	-122.00	13.50
950521	2200	4.78	254	12.74	83.85	1015	5.01	77	36.77	-121.97	13.40
950521	2210	4.85	255	12.87	83.15	1015	5.12	78	36.77	-121.93	13.40
950521	2220	5.30	253	12.87	83.26	1015	5.16	77	36.78	-121.90	13.60
950521	2230	5.16	251	13.07	83.68	1015	5.08	73	36.78	-121.87	14.20
950521	2240	5.14	241	13.06	82.21	1014	5.00	73	36.79	-121.83	14.00
950521	2250	4.53	237	12.76	82.70	1014	4.94	61	36.80	-121.80	14.00
950521	2300	2.66	228	12.68	82.94	1014	0.92	153	36.80	-121.79	14.90
950521	2310	1.15	249	12.59	84.73	1014	0.80	15	36.80	-121.79	15.50
950521	2320	4.14	253	12.53	85.32	1014	2.90	245	36.81	-121.79	14.00
950521	2330	4.60	256	12.25	87.14	1013	4.74	256	36.80	-121.82	14.00
950521	2340	5.51	258	12.22	88.74	1013	4.80	256	36.79	-121.85	14.00
950521	2350	6.66	266	12.09	91.93	1013	4.69	256	36.78	-121.88	13.60
950522	0	6.17	272	11.88	91.96	1013	4.52	254	36.78	-121.91	13.30

950522	10	6.09	277	11.82	92.17	1013	4.59	254	36.77	-121.94	13.30
950522	20	6.50	286	11.88	89.82	1013	4.66	256	36.77	-121.97	13.40
950522	30	6.72	286	11.94	92.18	1013	3.60	257	36.76	-122.00	13.30
950522	40	6.64	283	11.90	94.03	1013	0.63	262	36.76	-122.01	13.10
950522	50	6.90	283	11.81	92.91	1013	0.69	264	36.76	-122.02	13.20
950522	100	6.90	283	11.83	93.50	1013	0.64	265	36.76	-122.02	13.30
950522	110	6.77	281	11.71	93.70	1013	0.64	256	36.76	-122.03	13.30
950522	120	6.86	284	11.61	93.33	1013	0.67	257	36.76	-122.03	13.20
950522	130	6.44	281	11.53	93.57	1013	0.69	258	36.75	-122.03	13.00
950522	140	6.55	283	11.56	92.32	1013	0.69	259	36.75	-122.04	12.90
950522	150	6.89	278	11.67	90.86	1013	0.65	253	36.75	-122.04	12.80
950522	200	6.65	278	11.68	91.32	1013	0.66	253	36.75	-122.05	12.90
950522	210	6.50	276	11.59	92.95	1013	0.51	250	36.75	-122.05	12.90
950522	220	6.50	279	11.47	94.09	1013	0.52	256	36.75	-122.05	13.00
950522	230	6.51	278	11.42	94.63	1013	0.58	258	36.75	-122.06	13.00
950522	240	6.73	278	11.37	95.38	1013	0.55	260	36.75	-122.06	13.10
950522	250	6.56	275	11.37	95.79	1013	0.83	258	36.75	-122.07	13.00
950522	300	6.91	273	11.36	95.99	1013	0.80	258	36.75	-122.07	12.80
950522	310	7.09	276	11.31	95.98	1013	0.80	260	36.75	-122.08	12.90
950522	320	7.37	278	11.35	94.72	1013	0.83	259	36.75	-122.08	12.90
950522	330	7.89	281	11.44	92.89	1013	0.84	254	36.74	-122.09	12.90
950522	340	7.90	283	11.48	92.77	1013	0.86	254	36.74	-122.09	12.90
950522	350	8.34	283	11.52	92.95	1013	1.03	250	36.74	-122.10	12.80
950522	400	7.85	285	11.49	93.40	1013	1.09	251	36.74	-122.11	12.60
950522	410	7.76	285	11.46	93.03	1013	1.13	252	36.74	-122.11	12.60
950522	420	7.53	288	11.49	93.38	1013	1.09	255	36.74	-122.12	12.60
950522	430	8.12	288	11.57	93.07	1013	1.02	253	36.74	-122.13	12.70
950522	440	8.63	287	11.58	92.72	1013	0.93	252	36.73	-122.13	12.90
950522	450	9.35	284	11.65	91.48	1013	0.81	255	36.73	-122.14	13.00
950522	500	9.72	278	11.67	90.46	1014	0.80	251	36.73	-122.14	13.00
950522	510	9.56	281	11.66	90.65	1014	0.82	254	36.73	-122.15	12.90
950522	520	9.18	292	11.68	90.30	1014	0.88	260	36.73	-122.15	12.80
950522	530	7.57	303	11.64	90.32	1014	0.96	263	36.73	-122.16	13.00
950522	540	6.28	309	11.64	91.66	1014	1.02	264	36.73	-122.17	13.10
950522	550	6.29	304	11.55	92.02	1014	0.81	258	36.73	-122.17	13.10
950522	600	6.58	303	11.57	92.15	1014	0.86	257	36.73	-122.18	13.00
950522	610	6.46	299	11.53	89.43	1014	0.85	259	36.73	-122.18	13.00
950522	620	6.06	306	11.69	88.01	1014	0.82	257	36.72	-122.19	13.00
950522	630	6.43	305	11.71	86.46	1014	0.84	253	36.72	-122.20	13.00
950522	640	6.60	301	11.70	85.53	1014	0.78	255	36.72	-122.20	12.90
950522	650	6.67	299	11.67	84.45	1014	0.85	257	36.72	-122.21	12.90
950522	700	5.90	298	11.63	85.24	1014	0.87	261	36.72	-122.21	12.90
950522	710	5.61	305	11.54	85.86	1014	0.80	264	36.72	-122.22	12.80
950522	720	5.45	302	11.51	83.84	1014	0.63	258	36.72	-122.22	12.80
950522	730	5.42	295	11.54	84.02	1014	0.57	260	36.72	-122.23	12.80
950522	740	5.24	300	11.53	83.93	1014	0.61	261	36.72	-122.23	12.90
950522	750	5.69	301	11.54	82.05	1014	0.56	263	36.72	-122.23	12.90
950522	800	6.15	288	11.53	81.48	1014	0.53	253	36.72	-122.24	12.90
950522	810	5.36	293	11.58	82.63	1014	0.55	257	36.72	-122.24	13.00
950522	820	5.52	291	11.61	80.66	1014	0.59	257	36.72	-122.24	13.00
950522	830	5.16	289	11.58	81.30	1014	0.57	261	36.72	-122.25	13.00
950522	840	6.49	280	11.58	83.25	1013	0.56	247	36.71	-122.25	12.90
950522	850	6.02	275	11.45	83.08	1013	0.49	238	36.71	-122.25	12.90
950522	900	6.36	279	11.43	81.06	1013	0.52	241	36.71	-122.26	12.90
950522	910	6.54	267	11.44	77.48	1013	0.44	241	36.71	-122.26	12.90
950522	920	6.02	267	11.46	76.71	1013	0.41	238	36.71	-122.26	12.90
950522	930	5.80	269	11.47	77.49	1013	0.48	243	36.71	-122.27	12.90
950522	940	5.55	272	11.52	77.62	1013	0.53	245	36.71	-122.27	12.90
950522	950	6.27	256	11.55	77.02	1013	0.45	242	36.71	-122.27	12.90
950522	1000	5.82	271	11.57	76.28	1013	0.52	249	36.70	-122.27	12.90
950522	1010	6.12	270	11.71	76.68	1013	0.58	250	36.70	-122.28	13.00
950522	1020	5.61	273	11.74	76.99	1013	0.70	257	36.70	-122.28	13.10
950522	1030	4.82	268	11.85	78.58	1013	0.73	252	36.70	-122.29	13.10

950522	1040	4.48	269	11.82	80.13	1013	0.75	258	36.70	-122.29	13.20
950522	1050	4.28	277	11.87	81.24	1013	0.76	265	36.70	-122.30	13.20
950522	1100	5.99	277	12.00	82.18	1013	0.76	259	36.70	-122.30	13.20
950522	1110	6.38	285	11.98	85.61	1013	0.64	263	36.70	-122.31	13.30
950522	1120	7.23	273	11.88	86.16	1013	0.68	258	36.70	-122.31	13.20
950522	1130	6.28	283	11.76	86.79	1013	0.71	261	36.70	-122.32	13.20
950522	1140	6.32	290	11.78	85.79	1013	0.68	265	36.70	-122.32	13.30
950522	1150	7.19	286	11.72	85.13	1013	0.67	257	36.70	-122.32	13.30
950522	1200	6.22	290	11.69	87.22	1013	0.74	261	36.70	-122.33	13.30
950522	1210	6.33	287	11.65	88.76	1013	0.69	261	36.70	-122.33	13.30
950522	1220	6.02	288	11.51	89.74	1013	0.74	263	36.70	-122.34	13.30
950522	1230	5.97	288	11.35	91.53	1013	0.70	262	36.69	-122.34	13.30
950522	1240	6.84	297	11.21	91.68	1013	0.31	285	36.69	-122.35	13.30
950522	1250	5.81	313	10.94	93.90	1013	4.71	80	36.70	-122.33	13.20
950522	1300	5.46	314	10.79	94.92	1013	4.72	79	36.70	-122.30	13.10
950522	1310	5.41	313	10.80	95.35	1013	4.79	79	36.71	-122.27	12.80
950522	1320	4.84	314	10.84	95.91	1013	4.77	76	36.71	-122.24	12.80
950522	1330	4.75	317	10.86	96.01	1013	4.79	74	36.72	-122.21	12.80
950522	1340	4.80	316	10.98	95.79	1013	4.79	74	36.73	-122.18	13.10
950522	1350	4.59	319	11.09	94.64	1013	4.86	75	36.73	-122.15	12.90
950522	1400	4.62	315	11.13	93.95	1013	4.82	73	36.74	-122.11	12.80
950522	1410	4.86	314	11.15	94.00	1013	4.83	76	36.75	-122.08	13.10
950522	1420	5.00	306	11.16	94.00	1013	4.77	76	36.75	-122.05	13.00
950522	1430	4.87	298	11.13	94.02	1013	4.65	76	36.76	-122.02	13.00
950522	1440	5.16	292	11.10	94.02	1013	4.63	78	36.76	-121.99	13.20
950522	1450	5.03	287	11.06	94.25	1013	4.61	79	36.77	-121.96	13.40
950522	1500	5.56	284	11.10	94.68	1013	4.68	79	36.77	-121.93	13.50
950522	1510	5.23	281	11.12	95.45	1013	4.72	75	36.78	-121.90	13.60
950522	1520	4.96	281	11.17	95.46	1014	4.75	76	36.79	-121.87	13.70
950522	1530	4.29	281	11.23	94.69	1014	4.70	74	36.79	-121.84	13.70
950522	1540	4.08	279	11.25	93.56	1014	4.14	67	36.80	-121.81	13.60
950522	1550	3.31	282	11.30	91.91	1014	0.54	91	36.80	-121.79	13.40
950522	1600	2.06	336	11.29	92.63	1014	0.84	294	36.80	-121.80	12.90
950522	1610	3.47	315	11.18	93.78	1014	0.26	109	36.81	-121.80	13.50
950522	1620	2.83	297	11.11	92.35	1014	1.00	294	36.81	-121.80	13.50
950522	1630	3.77	282	11.12	91.03	1014	0.88	281	36.81	-121.80	13.40
950522	1640	2.67	284	11.06	92.72	1014	0.46	279	36.81	-121.81	13.50
950522	1650	3.44	290	11.08	93.73	1014	0.97	292	36.81	-121.82	13.30
950522	1700	4.47	292	11.19	92.73	1014	1.68	283	36.81	-121.82	13.50
950522	1710	3.53	320	11.20	91.73	1014	0.09	351	36.81	-121.83	13.70
950522	1720	4.94	308	11.20	90.23	1014	0.19	317	36.81	-121.83	13.60
950522	1730	1.43	138	11.30	89.92	1014	0.62	151	36.81	-121.83	13.70
950522	1740	4.04	17	11.32	89.39	1014	0.33	129	36.81	-121.83	13.80
950522	1750	1.58	306	11.40	89.06	1014	1.92	295	36.81	-121.83	13.60
950522	1800	4.71	304	11.42	88.45	1014	0.34	280	36.81	-121.84	13.70
950522	1810	3.43	329	11.44	89.49	1014	0.79	296	36.82	-121.85	13.90
950522	1820	5.65	286	11.49	89.35	1014	1.25	295	36.82	-121.85	13.90
950522	1830	4.69	295	11.35	89.92	1014	0.29	27	36.82	-121.86	14.00
950522	1840	4.75	277	11.37	89.63	1014	2.04	285	36.82	-121.86	13.70
950522	1850	4.69	292	11.41	89.61	1014	0.88	95	36.82	-121.86	13.90
950522	1900	4.56	287	11.59	89.03	1014	2.56	245	36.82	-121.87	13.60
950522	1910	5.09	271	11.28	89.79	1014	3.70	244	36.81	-121.89	13.70
950522	1920	4.29	262	11.24	90.13	1014	3.68	242	36.80	-121.91	13.80
950522	1930	4.32	261	11.25	90.04	1014	3.70	244	36.80	-121.93	13.60
950522	1940	4.20	259	11.26	89.82	1014	3.73	238	36.79	-121.96	13.60
950522	1950	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.50
950522	2000	-99.00	-99	-99.00	-99.00	-99	-99.00	-99	-99.00	-99.00	13.20
950522	2010	5.85	266	11.19	91.91	1014	0.49	276	36.76	-122.01	13.10
950522	2020	5.90	280	11.07	94.14	1014	0.37	293	36.76	-122.02	13.10
950522	2030	5.45	276	10.95	95.95	1014	0.45	282	36.76	-122.02	13.20
950522	2040	5.46	269	10.93	96.28	1014	0.43	269	36.76	-122.02	13.30
950522	2050	5.45	274	10.93	96.54	1014	0.39	274	36.76	-122.02	13.20
950522	2100	5.64	304	10.97	96.93	1014	0.40	311	36.76	-122.03	13.00

950522	2110	5.68	308	10.95	97.24	1014	0.40	312	36.76	-122.03	13.00
950522	2120	5.44	308	10.99	97.46	1014	0.29	312	36.76	-122.03	13.10
950522	2130	5.99	300	11.06	97.06	1014	0.26	293	36.76	-122.03	13.10
950522	2140	5.85	297	11.13	96.21	1014	0.26	288	36.76	-122.03	13.00
950522	2150	5.85	289	11.18	95.97	1014	0.22	280	36.76	-122.03	13.10
950522	2200	6.67	276	11.31	94.74	1014	0.28	264	36.76	-122.04	13.00
950522	2210	6.90	267	11.33	93.66	1014	0.22	249	36.76	-122.04	13.00
950522	2220	5.78	248	11.34	92.81	1014	0.22	223	36.76	-122.04	13.00
950522	2230	8.47	267	11.32	92.02	1014	0.48	254	36.76	-122.04	13.10
950522	2240	8.31	269	11.35	90.24	1014	0.44	255	36.76	-122.04	13.00
950522	2250	9.07	266	11.43	89.88	1014	0.48	254	36.76	-122.05	13.10
950522	2300	9.44	264	11.45	89.63	1013	0.42	253	36.76	-122.05	13.20
950522	2310	9.12	256	11.41	88.86	1013	0.36	241	36.76	-122.05	13.20
950522	2320	8.84	258	11.42	88.19	1013	0.42	242	36.76	-122.05	13.30
950522	2330	8.19	255	11.45	87.36	1013	0.47	240	36.76	-122.06	13.30
950522	2340	8.26	260	11.42	87.55	1013	0.48	240	36.76	-122.06	13.30
950522	2350	8.77	255	11.47	87.95	1013	0.50	238	36.75	-122.06	13.20
950523	0	9.30	252	11.44	87.96	1013	0.42	237	36.75	-122.07	13.20
950523	10	8.21	249	11.47	88.43	1013	0.35	234	36.75	-122.07	13.20
950523	20	9.53	246	11.43	88.09	1013	0.53	233	36.75	-122.07	13.20
950523	30	9.03	263	11.44	87.85	1013	0.58	250	36.75	-122.07	12.90
950523	40	8.46	264	11.51	87.82	1013	0.64	249	36.75	-122.08	12.90
950523	50	7.72	275	11.56	87.70	1013	0.59	267	36.75	-122.08	12.80
950523	100	8.61	290	11.63	87.32	1013	0.43	288	36.75	-122.09	12.70
950523	110	9.02	266	11.51	87.49	1013	0.44	260	36.75	-122.09	12.70
950523	120	9.07	277	11.50	87.15	1013	0.72	272	36.75	-122.09	12.60
950523	130	8.71	272	11.45	87.55	1013	0.69	264	36.75	-122.10	12.60
950523	140	8.52	273	11.45	87.38	1013	0.86	253	36.75	-122.10	12.60
950523	150	8.49	270	11.50	86.42	1013	0.84	250	36.75	-122.11	12.60
950523	200	8.73	274	11.48	86.83	1013	0.87	253	36.74	-122.11	12.50
950523	210	8.91	259	11.36	87.09	1013	0.65	243	36.74	-122.12	12.60
950523	220	8.86	273	11.29	87.32	1013	0.73	261	36.74	-122.12	12.70
950523	230	9.84	270	11.29	85.63	1013	0.66	259	36.74	-122.13	12.80
950523	240	9.99	261	11.31	85.43	1013	0.62	249	36.74	-122.13	12.70
950523	250	10.61	259	11.32	85.39	1013	0.63	244	36.74	-122.13	12.70
950523	300	10.37	264	11.32	85.52	1013	0.66	249	36.74	-122.14	12.80
950523	310	9.20	266	11.32	86.28	1014	0.70	248	36.74	-122.14	12.80
950523	320	8.72	275	11.28	87.43	1014	0.80	254	36.74	-122.15	12.90
950523	330	8.38	281	11.28	87.96	1014	0.78	258	36.73	-122.15	13.00
950523	340	8.02	281	11.33	88.71	1014	0.87	257	36.73	-122.16	13.00
950523	350	7.13	279	11.33	89.92	1014	0.89	255	36.73	-122.16	13.10
950523	400	7.07	276	11.32	90.55	1014	0.92	255	36.73	-122.17	13.00
950523	410	7.93	256	11.30	89.76	1014	0.78	236	36.73	-122.18	12.90
950523	420	7.77	276	11.34	90.13	1014	0.85	252	36.73	-122.18	12.90
950523	430	7.59	279	11.39	90.32	1014	0.80	252	36.73	-122.19	13.00
950523	440	6.82	283	11.39	91.45	1014	0.92	256	36.73	-122.19	13.00
950523	450	6.47	282	11.27	92.03	1014	0.84	255	36.72	-122.20	12.90
950523	500	5.10	297	11.28	92.66	1014	0.88	266	36.72	-122.20	12.90
950523	510	4.66	295	11.31	93.19	1014	0.71	262	36.72	-122.21	13.00
950523	520	4.82	286	11.27	93.18	1014	0.52	248	36.72	-122.21	13.00
950523	530	4.51	279	11.33	93.58	1014	0.55	244	36.72	-122.22	13.00
950523	540	4.57	279	11.31	94.00	1014	0.64	252	36.72	-122.22	13.00
950523	550	4.41	285	11.29	94.31	1014	0.58	257	36.72	-122.22	13.10
950523	600	4.49	297	11.28	95.38	1014	0.82	261	36.72	-122.23	13.10
950523	610	4.26	291	11.31	95.86	1014	0.70	262	36.72	-122.23	13.20
950523	620	4.08	294	11.27	95.99	1014	0.73	266	36.72	-122.24	13.20
950523	630	4.12	293	11.29	96.19	1014	0.72	269	36.72	-122.24	13.30
950523	640	4.06	295	11.26	96.25	1014	0.65	267	36.72	-122.25	13.30
950523	650	3.62	295	11.31	96.53	1014	0.75	271	36.72	-122.25	13.30
950523	700	3.11	289	11.31	97.02	1014	0.69	272	36.72	-122.26	13.30
950523	710	3.40	290	11.33	97.36	1014	0.68	273	36.72	-122.26	13.40
950523	720	3.77	292	11.39	97.52	1013	0.65	279	36.72	-122.27	13.40

950523	730	3.52	286	11.40	97.54	1013	0.75	270	36.72	-122.27	13.40
950523	740	3.53	296	11.40	97.77	1013	0.76	271	36.72	-122.28	13.40
950523	750	3.33	298	11.44	97.77	1013	0.83	255	36.72	-122.28	13.40
950523	800	3.98	310	11.53	97.22	1013	0.64	261	36.72	-122.29	13.30
950523	810	3.67	320	11.59	97.09	1013	0.74	269	36.71	-122.29	13.20
950523	820	4.46	307	11.61	96.53	1013	0.73	260	36.71	-122.30	13.20
950523	830	4.33	306	11.66	95.70	1013	0.53	252	36.71	-122.30	13.20
950523	840	4.87	316	11.73	93.44	1013	0.59	254	36.71	-122.31	13.20
950523	850	4.47	323	11.83	92.62	1013	0.51	263	36.71	-122.31	13.20
950523	900	4.86	309	11.89	92.09	1013	0.64	251	36.71	-122.31	13.20
950523	910	4.42	296	11.84	92.84	1013	0.62	237	36.71	-122.32	13.10
950523	920	4.34	310	11.83	92.24	1013	0.53	252	36.71	-122.32	13.10
950523	930	4.99	305	11.82	92.51	1013	0.52	248	36.71	-122.32	13.10
950523	940	4.91	301	11.77	92.67	1013	0.58	257	36.70	-122.33	13.20
950523	950	5.00	308	11.70	92.35	1013	0.53	261	36.70	-122.33	13.20
950523	1000	5.93	304	11.68	91.90	1012	0.72	261	36.70	-122.33	13.20
950523	1010	5.39	311	11.67	92.02	1012	0.83	255	36.70	-122.34	13.30
950523	1020	5.03	316	11.68	92.11	1012	0.76	263	36.70	-122.34	13.30
950523	1030	4.72	321	11.60	92.33	1012	0.77	260	36.70	-122.35	13.30
950523	1040	4.30	317	11.61	92.94	1012	0.55	256	36.70	-122.35	13.30
950523	1050	4.47	321	11.60	92.65	1012	0.55	266	36.70	-122.36	13.30
950523	1100	4.30	316	11.64	92.65	1012	0.55	250	36.70	-122.36	13.40
950523	1110	5.88	304	11.63	92.08	1012	0.46	258	36.70	-122.36	13.40
950523	1120	6.78	298	11.53	91.77	1012	0.47	254	36.70	-122.37	13.30
950523	1130	6.73	302	11.51	91.09	1012	0.46	262	36.70	-122.37	13.30
950523	1140	6.09	308	11.45	91.95	1012	0.43	264	36.70	-122.37	13.30
950523	1150	5.84	315	11.44	92.30	1012	0.30	276	36.70	-122.38	13.30
950523	1200	7.01	304	11.38	92.06	1012	0.43	267	36.70	-122.38	13.30
950523	1210	6.38	308	11.35	92.37	1012	0.47	267	36.70	-122.38	13.30
950523	1220	6.84	303	11.35	92.56	1012	0.46	264	36.70	-122.38	13.30
950523	1230	6.80	302	11.35	92.52	1012	0.47	258	36.70	-122.39	13.40
950523	1240	6.20	309	11.34	92.70	1012	0.42	263	36.70	-122.39	13.40
950523	1250	6.12	346	11.37	92.35	1012	3.71	76	36.70	-122.38	13.40
950523	1300	6.57	352	11.29	91.97	1012	4.61	77	36.71	-122.35	13.30
950523	1310	5.78	346	11.25	92.14	1012	4.83	78	36.71	-122.32	13.10
950523	1320	4.71	342	11.18	92.77	1012	4.74	78	36.72	-122.29	12.90
950523	1330	4.31	334	11.15	93.81	1012	4.66	78	36.72	-122.26	12.90
950523	1340	4.07	333	11.13	94.08	1012	4.72	77	36.73	-122.23	12.90
950523	1350	3.06	341	11.12	95.72	1013	4.92	79	36.73	-122.20	12.80
950523	1400	2.52	330	11.07	96.56	1013	4.97	79	36.74	-122.17	12.80
950523	1410	1.57	275	11.10	97.96	1013	4.88	77	36.74	-122.13	12.90
950523	1420	1.83	251	11.09	98.33	1013	4.82	75	36.75	-122.10	13.10
950523	1430	1.89	250	11.09	98.41	1013	4.89	75	36.75	-122.07	13.10
950523	1440	1.23	258	11.14	98.25	1013	4.69	75	36.76	-122.04	13.10
950523	1450	1.60	240	11.24	98.21	1013	4.68	76	36.77	-122.01	13.30
950523	1500	2.07	233	11.33	98.18	1013	4.65	76	36.77	-121.98	13.40
950523	1510	1.82	238	11.33	97.56	1013	4.69	79	36.78	-121.95	13.30
950523	1520	2.46	221	11.43	97.03	1013	4.76	78	36.78	-121.92	13.30
950523	1530	3.13	230	11.35	94.56	1013	4.74	79	36.79	-121.89	13.50
950523	1540	2.66	233	11.48	93.94	1013	4.66	79	36.79	-121.85	13.60
950523	1550	2.55	221	11.58	92.66	1013	4.68	73	36.80	-121.82	13.70
950523	1600	1.56	212	11.58	92.85	1013	1.77	73	36.80	-121.80	13.40
950523	1610	2.21	255	11.63	93.03	1013	0.27	55	36.80	-121.80	13.30
950523	1620	2.86	240	11.53	92.38	1013	0.85	295	36.81	-121.80	13.60
950523	1630	1.87	245	11.53	92.09	1013	0.13	99	36.81	-121.80	13.60
950523	1640	1.64	229	11.59	91.93	1013	1.52	294	36.81	-121.81	13.80
950523	1650	1.59	245	11.83	91.52	1014	0.38	109	36.81	-121.81	13.90
950523	1700	0.67	185	11.72	90.93	1013	0.16	145	36.81	-121.81	13.40
950523	1710	2.03	224	11.59	91.19	1013	0.94	264	36.81	-121.81	13.60
950523	1720	2.11	241	11.58	91.88	1013	1.09	269	36.81	-121.82	13.80
950523	1730	2.30	238	11.58	92.18	1013	0.59	266	36.81	-121.82	13.90
950523	1740	2.67	254	11.67	93.74	1013	0.56	264	36.81	-121.82	13.90
950523	1750	2.94	259	11.57	93.98	1013	0.54	263	36.81	-121.83	13.90

950523	1800	2.68	259	11.56	94.00	1013	0.52	263	36.81	-121.83	14.00
950523	1810	2.61	245	11.59	94.04	1014	0.55	234	36.81	-121.84	14.00
950523	1820	3.34	253	11.60	94.43	1014	0.65	231	36.81	-121.84	13.90
950523	1830	3.32	250	11.56	94.64	1014	0.57	228	36.80	-121.84	13.90
950523	1840	3.72	247	11.52	95.43	1014	0.44	222	36.80	-121.84	13.90
950523	1850	3.21	260	11.45	95.95	1014	0.43	225	36.80	-121.85	13.90
950523	1900	3.35	269	11.48	95.78	1014	0.59	243	36.80	-121.85	13.90
950523	1910	2.98	269	11.49	95.44	1014	0.61	241	36.80	-121.85	13.90
950523	1920	2.77	268	11.50	95.13	1014	0.60	243	36.80	-121.86	13.90
950523	1930	2.81	265	11.53	95.07	1014	0.67	243	36.79	-121.86	14.00
950523	1940	2.44	257	11.54	94.95	1014	0.56	244	36.79	-121.86	14.10
950523	1950	2.04	256	11.63	94.43	1014	0.62	242	36.79	-121.87	14.20
950523	2000	2.10	255	11.70	93.95	1014	0.55	248	36.79	-121.87	14.40
950523	2010	2.01	240	11.71	93.62	1014	0.66	240	36.79	-121.87	14.30
950523	2020	2.02	240	11.75	93.23	1014	0.53	249	36.79	-121.88	14.10
950523	2030	2.07	228	11.78	93.42	1013	0.56	245	36.79	-121.88	14.10
950523	2040	1.59	248	11.75	93.75	1013	0.61	253	36.79	-121.88	14.10
950523	2050	1.67	245	11.79	93.43	1013	0.69	234	36.78	-121.89	14.20
950523	2100	1.86	236	11.88	93.02	1013	0.67	235	36.78	-121.89	14.20
950523	2110	2.00	234	11.89	92.33	1013	0.62	240	36.78	-121.90	14.20
950523	2120	2.75	251	11.89	92.13	1013	0.55	245	36.78	-121.90	14.20
950523	2130	4.09	251	11.84	92.24	1013	0.49	241	36.78	-121.90	14.20
950523	2140	4.68	256	11.71	93.20	1013	0.48	244	36.78	-121.91	14.00
950523	2150	4.77	262	11.65	93.69	1013	0.46	236	36.77	-121.91	13.90
950523	2200	5.41	265	11.61	93.88	1013	0.43	251	36.77	-121.91	13.90
950523	2210	6.04	262	11.53	94.00	1013	0.37	250	36.77	-121.91	13.80
950523	2220	6.04	276	11.52	94.04	1013	0.31	264	36.77	-121.92	13.80
950523	2230	7.17	299	11.37	94.13	1013	0.40	301	36.77	-121.92	13.80
950523	2240	7.26	301	11.38	93.91	1013	0.32	304	36.77	-121.92	13.80
950523	2250	7.48	264	11.39	93.32	1012	0.34	257	36.77	-121.92	13.80
950523	2300	7.56	261	11.38	92.76	1012	0.34	256	36.77	-121.92	13.80
950523	2310	7.32	267	11.40	92.36	1012	0.36	263	36.77	-121.93	13.80
950523	2320	7.26	268	11.36	92.07	1012	0.41	267	36.77	-121.93	13.70
950523	2330	6.76	261	11.44	91.77	1012	0.39	258	36.77	-121.93	13.60
950523	2340	7.25	275	11.46	91.48	1012	0.33	274	36.77	-121.93	13.50
950523	2350	7.41	258	11.48	90.99	1012	0.31	259	36.77	-121.94	13.50
950524	0	7.63	262	11.53	90.61	1012	0.36	261	36.77	-121.94	13.60
950524	10	7.44	270	11.54	90.27	1012	0.45	265	36.77	-121.94	13.60
950524	20	7.60	260	11.57	90.25	1012	0.61	258	36.77	-121.95	13.60
950524	30	7.96	259	11.61	90.28	1012	0.63	255	36.77	-121.95	13.50
950524	40	8.56	263	11.56	90.42	1012	0.53	262	36.77	-121.95	13.50
950524	50	8.00	258	11.58	90.65	1012	0.62	259	36.77	-121.96	13.50
950524	100	7.30	255	11.59	90.95	1012	0.53	250	36.77	-121.96	13.50
950524	110	7.74	275	11.61	91.17	1012	0.64	271	36.77	-121.97	13.40
950524	120	8.29	267	11.54	91.25	1012	0.58	267	36.77	-121.97	13.30
950524	130	8.19	260	11.56	91.43	1012	0.54	262	36.77	-121.97	13.30
950524	140	8.18	258	11.57	91.29	1012	0.65	256	36.77	-121.98	13.10
950524	150	8.35	247	11.62	91.57	1012	0.54	240	36.77	-121.98	13.00
950524	200	8.24	266	11.55	91.46	1012	0.60	251	36.77	-121.98	13.00
950524	210	7.46	264	11.61	92.12	1012	0.64	250	36.76	-121.99	13.10
950524	220	7.70	278	11.56	91.93	1012	0.74	263	36.76	-121.99	13.00
950524	230	7.31	288	11.59	91.87	1012	0.57	274	36.76	-122.00	13.00
950524	240	7.36	274	11.58	91.99	1012	0.61	263	36.76	-122.00	13.00
950524	250	6.93	278	11.59	91.64	1012	0.73	262	36.76	-122.01	13.00
950524	300	6.96	266	11.57	91.64	1012	0.74	261	36.76	-122.01	13.10
950524	310	7.42	279	11.57	91.85	1012	0.77	271	36.76	-122.02	13.10
950524	320	7.24	276	11.60	92.16	1012	0.79	265	36.76	-122.02	13.10
950524	330	7.31	275	11.54	92.10	1012	0.78	265	36.76	-122.03	13.10
950524	340	7.11	275	11.51	92.06	1012	0.78	260	36.76	-122.03	13.00
950524	350	6.41	286	11.52	92.47	1012	0.73	270	36.76	-122.04	13.00
950524	400	6.72	279	11.50	92.07	1012	0.77	270	36.76	-122.04	13.00
950524	410	6.71	295	11.46	92.29	1012	0.76	290	36.76	-122.05	13.10

950524	420	7.02	300	11.43	92.06	1012	0.76	290	36.76	-122.05	13.00
950524	430	6.52	300	11.44	92.08	1012	0.76	289	36.76	-122.06	13.10
950524	440	6.90	300	11.44	92.18	1012	0.66	288	36.76	-122.06	13.20
950524	450	6.85	294	11.37	92.32	1012	0.63	289	36.77	-122.06	13.10
950524	500	6.83	290	11.32	92.05	1012	0.72	283	36.77	-122.07	13.10
950524	510	6.62	304	11.38	91.68	1012	1.37	111	36.77	-122.07	13.10
950524	520	5.82	303	11.41	92.03	1012	3.04	109	36.76	-122.05	13.20
950524	530	5.14	301	11.55	92.18	1012	3.05	110	36.76	-122.03	13.20
950524	540	5.41	293	11.51	91.74	1012	1.91	114	36.75	-122.02	12.90
950524	550	5.67	289	11.38	91.59	1012	0.56	279	36.75	-122.01	12.90
950524	600	6.09	292	11.36	91.80	1012	0.51	288	36.75	-122.02	12.90
950524	610	6.02	291	11.35	91.50	1012	0.58	281	36.75	-122.02	12.80
950524	620	6.13	279	11.40	91.64	1012	0.52	271	36.75	-122.02	13.00
950524	630	6.03	279	11.39	91.25	1012	0.54	267	36.75	-122.03	13.00
950524	640	5.44	293	11.41	91.54	1012	0.60	278	36.75	-122.03	13.00
950524	650	5.39	290	11.36	90.87	1012	0.63	271	36.75	-122.04	13.00
950524	700	5.24	290	11.39	90.47	1012	0.64	276	36.75	-122.04	13.00
950524	710	4.75	305	11.44	90.70	1012	0.67	283	36.75	-122.04	12.90
950524	720	4.93	301	11.44	90.98	1012	0.66	286	36.75	-122.05	12.90
950524	730	4.38	307	11.45	90.63	1012	0.70	289	36.75	-122.05	13.10
950524	740	4.20	303	11.43	90.57	1012	0.69	291	36.76	-122.06	13.10
950524	750	4.54	318	11.43	90.76	1012	0.72	303	36.76	-122.06	13.20
950524	800	4.76	319	11.42	90.22	1012	0.60	326	36.76	-122.06	13.20
950524	810	4.67	328	11.48	90.15	1012	0.71	328	36.76	-122.07	13.20
950524	820	4.67	314	11.45	90.77	1012	0.66	322	36.77	-122.07	13.20
950524	830	5.09	327	11.43	90.69	1012	0.64	332	36.77	-122.07	13.20
950524	840	4.48	330	11.41	90.49	1012	0.72	334	36.77	-122.07	13.20
950524	850	4.53	315	11.47	90.69	1012	0.48	6	36.77	-122.08	13.20
950524	900	4.53	293	11.45	90.55	1012	2.85	114	36.77	-122.07	13.20
950524	910	4.71	296	11.42	90.63	1012	2.74	116	36.76	-122.05	13.10
950524	920	5.20	290	11.38	90.23	1012	2.78	124	36.76	-122.03	13.00
950524	930	5.28	283	11.38	89.96	1011	2.12	127	36.75	-122.02	13.00
950524	940	4.68	309	11.34	89.30	1011	0.76	315	36.75	-122.02	13.00
950524	950	4.82	302	11.35	90.01	1011	0.77	309	36.75	-122.02	12.90
950524	1000	4.53	304	11.33	89.74	1011	0.79	307	36.75	-122.02	12.90
950524	1010	4.47	296	11.30	90.07	1011	0.82	314	36.76	-122.03	12.80
950524	1020	4.99	306	11.34	89.88	1011	0.76	318	36.76	-122.03	12.90
950524	1030	4.21	315	11.31	89.18	1011	0.79	312	36.76	-122.04	12.90
950524	1040	4.49	301	11.33	89.37	1011	0.84	308	36.76	-122.04	12.90
950524	1050	4.97	307	11.37	89.74	1011	0.84	315	36.77	-122.04	12.90
950524	1100	4.43	309	11.28	89.53	1011	0.82	312	36.77	-122.05	12.90
950524	1110	4.38	318	11.27	88.93	1011	0.78	315	36.77	-122.05	13.00
950524	1120	4.29	324	11.28	88.60	1011	0.75	324	36.78	-122.06	13.00
950524	1130	4.80	319	11.26	88.92	1011	0.62	329	36.78	-122.06	13.00
950524	1140	4.09	297	11.27	89.02	1011	0.34	116	36.78	-122.06	13.10
950524	1150	5.95	290	11.16	88.63	1011	2.69	128	36.77	-122.05	13.00
950524	1200	4.85	287	11.16	88.23	1011	2.32	130	36.77	-122.04	12.90
950524	1210	5.27	283	11.17	88.74	1011	2.23	130	36.76	-122.03	12.90
950524	1220	4.22	285	11.19	88.82	1011	1.90	134	36.75	-122.01	13.10
950524	1230	5.74	310	11.19	89.80	1011	0.65	320	36.75	-122.01	13.00
950524	1240	6.22	309	11.12	88.37	1011	0.59	352	36.75	-122.01	13.00
950524	1250	4.87	291	11.16	87.92	1011	4.56	73	36.76	-122.00	13.10
950524	1300	4.93	276	11.14	88.38	1011	4.63	74	36.76	-121.97	13.40
950524	1310	5.20	272	11.16	88.67	1011	4.68	76	36.77	-121.94	13.40
950524	1320	4.93	265	11.12	88.63	1011	4.72	76	36.78	-121.91	13.30
950524	1330	5.25	267	11.12	89.04	1011	4.68	75	36.78	-121.88	13.40
950524	1340	4.83	257	11.10	89.62	1011	4.63	74	36.79	-121.85	13.60
950524	1350	4.72	252	11.24	89.47	1011	4.74	71	36.80	-121.82	13.60
950524	1400	4.82	253	11.17	90.23	1011	2.76	67	36.81	-121.79	13.30
950524	1410	1.39	281	11.01	91.94	1011	0.46	196	36.80	-121.79	13.30
950524	1420	1.05	275	11.04	90.94	1011	0.00	242	36.80	-121.79	13.00

APPENDIX I. RADIOSONDE METEOROLOGICAL DATA

Sounding program REV 7.62 using Omega
Ship   :PT_SUR
Location : 36.80 N 122.00 W   3 m
Rejected Sigma stations: a,b,c
Phase fitting length is 250 s from   0 min to 120 min
Sounding : 4
RS-number: 158735751
No PTU editing
No wind editing
Started at: 16 MAY 95 14:59 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1013.8	11.4	94	10.5	36	2.5	---------
0	5	7.8	42	1009.0	11.7	75	7.5	///	////	--CD-FGH-
0	10	5.7	60	1006.8	11.5	77	7.7	345	1.9	--CD-FGH-
0	15	4.9	82	1004.1	11.6	72	6.8	///	////	--CD-FGH-
0	20	6.8	139	997.3	12.1	68	6.4	342	2.4	--CD-FGH-
0	25	6.1	159	995.0	12.2	60	4.7	///	////	--CD-FGH-
0	30	6.0	184	991.9	12.3	60	4.8	345	2.5	--CD-FGH-
0	35	5.7	216	988.2	12.2	62	5.2	///	////	--CD-FGH-
0	40	6.3	248	984.5	12.1	61	4.9	345	2.9	--CD-FGH-
0	45	6.6	276	981.1	11.9	62	4.9	///	////	--CD-FGH-
0	50	5.7	309	977.3	11.7	63	4.9	344	3.1	--CD-FGH-
0	55	6.0	336	974.1	11.6	64	5.1	///	////	--CD-FGH-
1	0	6.0	364	970.9	11.6	64	5.1	342	3.6	--CD-FGH-
1	5	5.7	390	967.8	11.7	63	4.9	///	////	--CD-FGH-
1	10	6.0	427	963.5	11.6	63	4.9	343	3.2	--CD-FGH-
1	15	6.2	455	960.2	12.0	60	4.5	///	////	--CD-FGH-
1	20	5.7	480	957.4	12.4	58	4.4	342	3.3	--CD-FGH-
1	25	5.7	510	953.9	12.4	57	4.2	///	////	--CD-FGH-
1	30	5.9	541	950.4	12.1	58	4.1	343	3.5	--CD-FGH-
1	35	6.1	572	946.9	11.8	58	3.9	///	////	--CD-FGH-
1	40	5.8	600	943.7	11.5	59	3.8	343	3.9	--CD-FGH-
1	45	5.7	626	940.8	11.3	60	3.9	///	////	--CD-FGH-
1	50	5.7	651	938.0	11.0	61	3.8	343	4.0	--CD-FGH-
1	55	5.7	685	934.1	10.8	62	3.9	///	////	--CD-FGH-
2	0	5.7	712	931.2	10.6	62	3.7	344	4.2	--CD-FGH-
2	5	5.7	740	928.0	10.4	62	3.5	///	////	--CD-FGH-
2	10	5.7	772	924.4	10.4	60	3.0	345	4.3	--CD-FGH-
2	15	5.9	804	920.9	10.4	59	2.8	///	////	--CD-FGH-
2	20	6.0	831	917.8	10.1	59	2.5	346	4.4	--CD-FGH-
2	25	6.1	863	914.4	9.9	59	2.3	///	////	--CD-FGH-
2	30	6.1	896	910.7	9.6	59	2.0	348	4.4	--CD-FGH-
2	35	5.6	913	908.8	9.4	60	2.1	///	////	--CD-FGH-
2	40	5.6	940	905.8	9.2	60	1.9	350	4.2	--CD-FGH-
2	45	5.3	970	902.6	9.1	60	1.8	///	////	--CD-FGH-
2	50	5.3	991	900.3	8.9	60	1.6	352	4.3	--CD-FGH-

Sounding program REV 7.62 using Omega
Ship :PT_SUR
Location : 36.80 N 121.80 W 3 m
Rejected Sigma stations: a,b,c
Phase fitting length is 250 s from 0 min to 120 min
Sounding : 5
RS-number: 309140543
No PTU editing
No wind editing
Started at: 16 MAY 95 18:01 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1013.4	12.1	90	10.5	279	2.2	---------
0	5	2.7	17	1011.7	13.3	70	8.0	///	////	-BCD--GH-
0	10	1.8	21	1011.3	13.0	72	8.1	285	2.3	-BCD--GH-
0	15	1.7	31	1010.1	12.9	74	8.4	///	////	-BCD--GH-
0	20	2.0	42	1008.8	12.8	75	8.5	281	2.1	-BCD--GH-
0	25	1.7	46	1008.3	12.8	76	8.7	///	////	-BCD-FGH-
0	30	1.8	56	1007.1	12.6	77	8.7	281	2.3	-BCD-FGH-
0	35	1.8	70	1005.3	12.5	78	8.8	///	////	-BCD-FGH-
0	40	1.8	75	1004.9	12.5	78	8.8	261	2.3	-BCD-FGH-
0	45	1.8	83	1003.9	12.5	77	8.6	///	////	-BCD-FGH-
0	50	1.7	93	1002.6	12.5	75	8.2	257	2.3	-BCD-FGH-
0	55	2.0	103	1001.4	12.5	74	8.0	///	////	-BCD-FGH-
1	0	1.9	113	1000.2	12.5	73	7.8	249	2.4	-BCD-FGH-
1	5	1.6	119	999.5	12.4	73	7.7	///	////	-BCD-FGH-
1	10	1.8	128	998.5	12.4	73	7.7	249	2.5	-BCD-FGH-
1	15	1.9	137	997.4	12.5	73	7.8	///	////	-BCD-FGH-
1	20	1.9	150	995.8	12.5	73	7.8	249	2.7	-BCD-FGH-
1	25	1.6	153	995.5	12.7	72	7.8	///	////	-BCD-FGH-
1	30	1.6	160	994.6	12.8	70	7.5	249	2.7	-BCD-FGH-
1	35	1.4	164	994.1	12.8	70	7.5	///	////	-BCD-FGH-
1	40	1.9	185	991.7	12.8	69	7.3	252	2.7	-BCD-FGH-
1	45	1.7	190	991.1	12.8	69	7.3	///	////	-BCD-FGH-
1	50	1.7	201	989.8	12.8	69	7.3	250	2.7	-BCD-FGH-
1	55	1.8	208	988.9	12.7	69	7.2	///	////	-BCD-FGH-
2	0	1.9	218	987.8	12.6	69	7.1	247	2.8	-BCD-FGH-
2	5	2.3	228	986.6	12.6	69	7.1	///	////	-BCD-FGH-
2	10	1.6	234	985.9	12.5	69	7.0	247	2.9	-BCD-FGH-
2	15	1.8	244	984.7	12.4	69	6.9	///	////	-BCD-FGH-
2	20	1.8	256	983.3	12.3	68	6.6	247	2.9	-BCD-FGH-
2	25	2.0	266	982.1	12.3	69	6.8	///	////	-BCD-FGH-
2	30	1.9	275	981.1	12.1	69	6.6	253	2.9	-BCD-FGH-
2	35	1.7	283	980.1	12.1	69	6.6	///	////	-BCD-FGH--
2	40	1.9	291	979.2	12.1	69	6.6	257	3.0	-BCD-FGH--
2	45	1.9	302	977.9	11.9	70	6.7	///	////	-BCD-FGH--
2	50	1.8	311	976.8	11.8	70	6.6	251	3.1	-BCD-FGH--
2	55	1.8	320	975.7	11.9	71	6.9	///	////	-BCD-FGH--

Start Up Date 16 MAY 95 20:09 GMT
System test passed -No errors found
Sounding program REV 7.62 using Omega
Ship :PT_SUR
Location : 36.80 N 122.00 W 3 m
Rejected Sigma stations: a,b,c
Phase fitting length is 250 s from 0 min to 120 min
Sounding : 6
RS-number: 309140540
No PTU editing
No wind editing
Started at: 16 MAY 95 20:17 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1011.3	12.1	92	10.8	292	10.4	---------
0	5	-1.7	-7	1012.5	15.5	59	7.6	///	////	--CD-FGH-
0	10	-1.0	-7	1012.5	15.6	61	8.2	300	10.5	--CD-FGH-
0	15	-0.6	-7	1012.5	15.5	63	8.5	///	////	--CD-FGH-
0	20	1.5	34	1007.6	14.9	64	8.2	301	10.7	--CD-FGH-
0	25	4.6	119	997.4	13.6	70	8.3	///	////	--CD-FGH-
0	30	4.9	149	993.9	12.9	74	8.4	298	10.2	--CD-FGH-
0	35	6.4	178	990.5	12.7	75	8.4	///	////	--CD--GH-
0	40	6.9	200	987.8	12.4	76	8.3	299	9.9	--CD--GH-
0	45	8.0	228	984.6	12.6	69	7.1	///	////	--CD-FGH-
0	50	7.2	251	981.8	13.2	58	5.2	298	9.7	--CD-FGH-
0	55	4.9	265	980.1	13.4	54	4.3	///	////	-BCD-FGH-
1	0	4.6	286	977.7	13.7	50	3.5	299	9.7	-BCD-FGH-
1	5	4.4	312	974.8	13.9	46	2.5	///	////	-BCD-FGH-
1	10	4.3	329	972.7	14.1	43	1.8	297	9.1	-BCD-FGH-
1	15	3.6	337	971.8	14.2	42	1.5	///	////	-BCD-FGH-
1	20	3.4	352	970.1	14.3	41	1.3	298	9.1	-BCD-FGH-
1	25	3.3	366	968.5	14.4	41	1.4	///	////	-BCD-FGH-
1	30	3.1	380	966.8	14.4	41	1.4	299	9.0	-BCD-FGH-
1	35	2.8	396	965.1	14.5	40	1.1	///	////	-BCD-FGH-
1	40	2.7	409	963.5	14.6	40	1.2	300	9.1	-BCD-FGH-
1	45	2.8	421	962.1	14.5	40	1.1	///	////	-BCD-FGH-
1	50	2.9	440	960.0	14.5	40	1.1	298	8.7	-BCD-FGH-
1	55	3.0	451	958.7	14.4	39	0.7	///	////	-BCD-FGH-
2	0	2.8	465	957.2	14.3	39	0.6	298	8.8	-BCD-FGH-
2	5	2.8	482	955.2	14.3	38	0.2	///	////	-BCD-FGH-
2	10	3.0	498	953.5	14.2	38	0.2	299	9.0	-BCD-FGH-
2	15	3.1	514	951.6	14.2	38	0.2	///	////	-BCD-FGH-
2	20	2.8	524	950.4	14.1	37	-0.3	300	8.9	-BCD-FGH-
2	25	2.8	539	948.8	14.1	37	-0.3	///	////	-BCD-FGH-
2	30	2.9	551	947.4	14.0	37	-0.4	299	8.9	-BCD-FGH-
2	35	2.8	565	945.8	14.0	37	-0.4	///	////	-BCD-FGH-

Sounding program REV 7.62 using Loran-C
Ship : PT_SUR
Location : 36.80 N 121.80 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 10
RS-number: 108234745
No PTU editing
No wind editing
Started at: 17 MAY 95 17:47 GMT

Time min	AscRate s	Hgt/MSL m/s	Pressure m	Temp hPa	RH degC	Dewp %	Dir degC	Speed deg	m/s	WndStat
0	0	0.0	3	1016.8	12.4	88	10.5	278	1.0	000000000
0	5	4.2	24	1014.1	12.7	63	5.9	///	////	111100000
0	10	4.1	44	1011.7	12.4	66	6.3	268	2.2	111100000
0	15	3.8	60	1009.8	12.3	69	6.8	///	////	111100000
0	20	3.5	74	1008.0	12.1	70	6.8	263	2.5	111100000
0	25	3.5	91	1006.1	12.0	72	7.2	///	////	111100000
0	30	3.5	107	1004.1	11.8	72	7.0	263	2.3	111100000
0	35	3.4	125	1001.9	11.6	73	7.0	///	////	111100000
0	40	3.3	144	999.7	11.4	74	7.0	259	2.4	111100000
0	45	3.3	158	998.0	11.3	75	7.1	///	////	111100000
0	50	3.3	174	996.1	11.1	76	7.1	256	2.3	111100000
0	55	3.7	198	993.1	10.9	77	7.1	///	////	111100000
1	0	3.5	213	991.5	10.7	78	7.1	254	2.3	111100000
1	5	3.6	234	988.9	10.5	79	7.1	///	////	111100000
1	10	3.7	255	986.4	10.3	80	7.1	250	2.3	111100000
1	15	4.0	280	983.5	10.0	82	7.1	///	////	111100000
1	20	4.3	302	980.9	9.8	83	7.1	251	2.3	111100000
1	25	3.9	318	978.9	9.7	85	7.3	///	////	111100000
1	30	4.0	332	977.3	9.5	85	7.2	250	2.2	111100000
1	35	3.8	346	975.6	9.4	86	7.2	///	////	111100000
1	40	4.0	375	972.3	9.1	88	7.3	246	1.8	111100000
1	45	4.0	399	969.4	8.9	89	7.2	///	////	111100000
1	50	3.8	417	967.3	8.6	89	6.9	247	1.3	111100000
1	55	4.0	434	965.3	8.6	90	7.1	///	////	111100000
2	0	4.2	457	962.6	8.4	90	6.9	241	1.7	111100000
2	5	4.6	483	959.5	8.2	90	6.7	///	////	111100000
2	10	4.5	509	956.5	8.1	91	6.8	237	2.1	111100000
2	15	4.6	537	953.4	8.1	88	6.3	///	////	111100000
2	20	4.4	548	952.1	8.7	79	5.3	240	2.9	111100000
2	25	4.2	562	950.4	10.2	70	5.0	///	////	111100000
2	30	4.0	576	948.8	11.8	63	5.0	240	3.4	111100000
2	35	3.4	590	947.2	12.6	59	4.9	///	////	111100000
2	40	3.2	605	945.6	12.7	55	4.0	237	4.0	111100000
2	45	2.8	620	943.9	12.8	52	3.3	///	////	111100000
2	50	2.9	635	942.1	13.1	50	3.0	236	4.2	111100000

Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.80 N 122.00 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 11
RS-number: 108234743
No PTU editing
No wind editing
Started at: 17 MAY 95 21:54 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1016.3	12.2	96	11.6	261	5.4	000000000
0	5	3.8	20	1014.1	13.3	72	8.4	///	////	111100000
0	10	4.1	44	1011.3	12.6	76	8.5	309	5.3	111100000
0	15	4.2	67	1008.4	12.4	78	8.7	///	////	111100000
0	20	4.1	85	1006.3	12.2	79	8.7	302	5.7	111100000
0	25	3.8	100	1004.5	12.1	81	9.0	///	////	111100000
0	30	3.7	115	1002.6	11.9	83	9.2	300	5.8	111100000
0	35	3.7	129	1000.9	11.8	83	9.1	///	////	111100000
0	40	3.5	148	998.7	11.6	84	9.0	286	7.0	111100000
0	45	3.2	160	997.3	11.5	84	8.9	///	////	110100000
0	50	3.3	185	994.4	11.3	85	8.9	272	9.7	110100000
0	55	3.3	197	992.9	11.2	86	9.0	///	////	111100000
1	0	3.3	215	990.7	11.0	87	9.0	281	8.0	111100000
1	5	3.3	229	989.0	10.9	86	8.7	///	////	111100000
1	10	3.4	250	986.6	10.7	87	8.7	291	7.1	111100000
1	15	3.5	265	984.8	10.7	87	8.7	///	////	111100000
1	20	3.3	284	982.5	10.5	87	8.5	291	7.3	111100000
1	25	3.4	296	981.1	10.4	87	8.4	///	////	111100000
1	30	3.2	312	979.2	10.2	87	8.2	291	7.2	111100000
1	35	3.5	336	976.4	10.1	88	8.2	///	////	111100000
1	40	3.4	351	974.7	9.9	88	8.1	292	7.1	111100000
1	45	3.4	368	972.6	9.7	89	8.0	///	////	111100000
1	50	3.2	379	971.3	9.6	89	7.9	290	7.2	111100000
1	55	3.4	401	968.7	9.6	90	8.1	///	////	111100000
2	0	3.5	416	967.1	9.4	90	7.9	288	7.0	111100000
2	5	3.4	439	964.4	9.3	91	8.0	///	////	111100000
2	10	3.4	452	962.8	9.2	91	7.9	287	6.9	111100000
2	15	3.3	468	960.9	9.1	92	7.9	///	////	111100000
2	20	3.7	490	958.4	8.9	91	7.6	285	6.5	111100000
2	25	3.4	505	956.6	8.9	91	7.6	///	////	111100000
2	30	3.5	522	954.6	9.4	89	7.7	285	5.6	111100000
2	35	3.3	538	952.9	9.5	88	7.7	///	////	111100000
2	40	3.4	555	950.9	9.8	83	7.1	283	4.9	111100000
2	45	3.4	571	949.1	10.2	78	6.6	///	////	111100000

Sounding program REV 7.62 using Loran-C
Ship : PT_SUR
Location : 36.70 N 121.90 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 14
RS-number: 108234746
No PTU editing
No wind editing
Started at: 18 MAY 95 15:17 GMT

Time min	AscRate s	Hgt/MSL m/s	Pressure m	Temp hPa	RH degC	Dewp %	Dir degC	Speed deg	m/s	WndStat
0	0	0.0	3	1016.6	10.4	93	9.3	237	0.6	000000000
0	5	4.0	25	1014.0	11.6	72	6.8	///	////	111100000
0	10	3.5	38	1012.5	11.0	75	6.8	240	3.1	111100000
0	15	3.8	57	1010.1	10.9	78	7.3	///	////	111100000
0	20	3.5	72	1008.3	10.8	79	7.4	241	2.6	111100000
0	25	3.3	85	1006.7	10.7	81	7.6	///	////	111100000
0	30	3.3	103	1004.6	10.5	82	7.6	237	1.0	111100000
0	35	3.3	123	1002.2	10.3	83	7.6	///	////	111100000
0	40	3.5	143	999.7	10.1	84	7.6	254	0.5	111100000
0	45	3.5	163	997.3	10.0	85	7.6	///	////	111100000
0	50	3.7	182	995.1	9.7	86	7.5	243	2.1	111100000
0	55	3.8	198	993.1	9.6	88	7.8	///	////	110100000
1	0	3.7	214	991.2	9.4	88	7.6	246	2.5	110100000
1	5	3.7	234	988.8	9.3	89	7.6	///	////	111100000
1	10	3.8	256	986.1	9.1	90	7.6	254	1.8	111100000
1	15	3.6	274	984.0	8.9	91	7.6	///	////	111100000
1	20	3.6	291	982.1	8.8	92	7.6	274	0.6	111100000
1	25	3.6	304	980.5	8.7	92	7.5	///	////	111100000
1	30	3.6	321	978.5	8.6	92	7.4	313	0.8	111100000
1	35	3.6	341	976.1	8.5	93	7.5	///	////	111100000
1	40	3.7	367	973.0	8.4	93	7.4	326	0.8	111100000
1	45	3.8	385	970.9	8.3	93	7.3	///	////	111100000
1	50	3.8	405	968.5	8.1	93	7.1	334	0.9	111100000
1	55	3.9	423	966.4	8.1	94	7.2	///	////	111100000
2	0	3.9	437	964.7	8.0	94	7.1	347	1.0	111100000
2	5	3.7	454	962.7	7.9	94	7.0	///	////	111100000
2	10	3.5	472	960.7	7.8	94	6.9	338	1.0	111100000
2	15	3.6	493	958.3	7.7	94	6.8	///	////	111100000
2	20	3.5	510	956.3	7.6	94	6.7	336	0.9	111100000
2	25	3.5	528	954.2	7.5	94	6.6	///	////	111100000
2	30	3.7	548	951.8	7.4	94	6.5	338	1.0	111100000
2	35	3.9	567	949.6	7.3	94	6.4	///	////	111100000
2	40	3.7	582	947.9	7.2	94	6.3	348	1.1	111100000
2	45	3.7	604	945.4	7.0	94	6.1	///	////	111100000

Sounding program REV 7.62 using Omega
Ship :PT_SUR
Location : 36.80 N 121.90 W 3 m
Rejected Sigma stations: a,b,c
Phase fitting length is 250 s from 0 min to 120 min
Sounding : 16
RS-number: 158735752
No PTU editing
No wind editing
Started at: 18 MAY 95 21:53 GMT

Time		AscRate	Hgt/MSL	Pressure	Temp	RH	Dewp	Dir	Speed	WndStat
min	s	m/s	m	hPa	degC	%	degC	deg	m/s	
0	0	0.0	3	1015.5	11.2	90	9.6	255	6.3	--------
0	5	3.7	21	1013.2	12.4	63	5.6	///	////	--CD--GH
0	10	4.5	48	1010.0	11.8	67	5.9	287	4.3	--CD--GH
0	15	5.4	77	1006.5	11.6	70	6.4	///	////	--CD--GH
0	20	5.2	107	1002.9	11.2	72	6.4	288	3.9	--CD--GH
0	25	5.3	137	999.2	11.0	74	6.6	///	////	--CD--GH
0	30	5.5	168	995.6	10.7	76	6.7	283	3.5	--CD--GH
0	35	5.8	190	992.9	10.4	77	6.6	///	////	--CD--GH
0	40	5.6	216	989.8	10.2	78	6.6	283	3.3	--CD--GH
0	45	5.5	252	985.5	9.8	80	6.6	///	////	--CD--GH
0	50	5.7	279	982.3	9.6	81	6.5	277	3.0	--CD--GH
0	55	5.5	301	979.7	9.3	82	6.4	///	////	--CD-FGH
1	0	5.3	328	976.6	9.2	83	6.5	277	2.8	--CD-FGH
1	5	5.1	346	974.4	9.3	83	6.6	///	////	--CD-FGH
1	10	5.0	366	972.0	9.4	83	6.7	264	2.3	--CD-FGH
1	15	4.4	383	970.0	9.7	81	6.6	///	////	--CD-FGH
1	20	4.0	398	968.2	10.1	78	6.5	258	2.3	--CD-FGH
1	25	3.9	418	966.0	12.3	63	5.5	///	////	--CD-FGH
1	30	3.7	439	963.5	13.0	59	5.2	258	2.3	--CD-FGH
1	35	3.9	460	961.1	13.2	59	5.4	///	////	--CD-FGH
1	40	3.7	478	959.1	13.4	51	3.5	260	2.3	--CD-FGH
1	45	3.7	494	957.2	15.1	33	-1.0	///	////	--CD-FGH
1	50	3.8	513	955.1	15.9	38	1.7	261	2.3	--CD-FGH
1	55	3.5	525	953.7	16.0	39	2.1	///	////	-BCD-FGH
2	0	3.2	536	952.5	16.0	39	2.1	258	2.3	-BCD-FGH
2	5	3.1	559	949.9	15.9	40	2.4	///	////	-BCD-FGH
2	10	3.1	571	948.6	15.8	41	2.6	260	2.2	-BCD-FGH
2	15	3.3	592	946.2	15.8	43	3.3	///	////	-BCD-FGH
2	20	3.1	606	944.7	15.8	44	3.6	254	2.1	-BCD-FGH
2	25	3.3	625	942.5	15.9	44	3.7	///	////	-BCD-FGH
2	30	3.6	643	940.5	15.9	44	3.7	261	2.0	-BCD-FGH
2	35	3.5	658	938.8	16.1	41	2.9	///	////	-BCD-FGH
2	40	3.4	674	937.1	16.3	37	1.7	266	1.8	-BCD-FGH
2	45	3.3	693	935.0	16.3	38	2.0	///	////	-BCD-FGH
2	50	3.5	711	933.0	16.2	39	2.3	267	1.8	-BCD-FGH
2	55	3.5	730	930.9	16.1	41	2.9	///	////	-BCD-FGH

Sounding program REV 7.62 using Omega
Ship :PT_SUR
Location : 36.78 N 121.90 W 3 m
Rejected Sigma stations: a,b,c
Phase fitting length is 250 s from 0 min to 120 min
Sounding : 18
RS-number: 158735842
No PTU editing
No wind editing
Started at: 19 MAY 95 15:35 GMT

Time min	AscRate s	Hgt/MSL m/s	Pressure m	Temp hPa	RH degC	Dewp %	Dir degC	Speed deg	m/s	WndStat
0	0	0.0	3	1014.6	10.0	100	10.0	93	0.9	--------
0	5	3.3	22	1012.4	11.0	80	7.7	///	////	--CD-FGH
0	10	3.9	42	1010.0	10.7	81	7.6	9	1.4	--CD-FGH
0	15	3.4	55	1008.4	10.7	83	8.0	///	////	--CD-FGH
0	20	3.3	70	1006.6	10.5	84	8.0	6	1.6	--CD-FGH
0	25	3.3	87	1004.5	10.4	86	8.2	///	////	--CD-FGH
0	30	3.3	102	1002.6	10.3	86	8.1	1	2.2	--CD-FGH
0	35	3.4	122	1000.3	10.2	87	8.2	///	////	--CD-FGH
0	40	3.3	141	998.0	10.1	87	8.1	5	2.1	--CD-FGH
0	45	3.4	156	996.2	10.0	88	8.1	///	////	--CD-FGH
0	50	3.4	173	994.1	9.9	88	8.1	15	1.9	--CD-FGH
0	55	3.4	189	992.2	9.8	88	8.0	///	////	--CD-FGH
1	0	3.4	204	990.5	9.7	88	7.9	23	1.9	--CD-FGH
1	5	3.3	220	988.6	9.7	89	8.0	///	////	-BCD-FGH
1	10	3.2	238	986.4	9.6	89	7.9	23	2.0	-BCD-FGH
1	15	3.3	255	984.3	9.5	89	7.8	///	////	-BCD-FGH
1	20	3.2	270	982.5	9.4	89	7.7	24	2.2	-BCD-FGH
1	25	3.3	289	980.3	9.3	89	7.6	///	////	-BCD-FGH
1	30	3.4	305	978.5	9.2	89	7.5	29	2.2	-BCD-FGH
1	35	3.4	322	976.4	9.1	89	7.4	///	////	-BCD-FGH
1	40	3.4	341	974.2	9.0	89	7.3	33	2.2	-BCD-FGH
1	45	3.3	354	972.6	9.0	89	7.3	///	////	-BCD-FGH
1	50	3.3	369	970.9	9.2	89	7.5	31	2.2	-BCD-FGH
1	55	3.2	382	969.3	10.1	90	8.6	///	////	-BCD-FGH
2	0	3.0	395	967.8	10.6	90	9.1	30	2.2	-BCD-FGH
2	5	2.9	409	966.2	11.4	90	9.9	///	////	-BCD-FGH
2	10	2.6	418	965.2	11.6	88	9.7	28	2.3	-BCD-FGH
2	15	2.5	429	963.9	12.1	88	10.2	///	////	-BCD-FGH
2	20	2.3	438	962.8	12.3	86	10.1	31	2.1	-BCD-FGH
2	25	2.5	454	960.9	12.3	82	9.4	///	////	-BCD-FGH
2	30	2.4	467	959.5	12.4	78	8.7	31	2.2	-BCD-FGH
2	35	2.4	481	957.9	12.5	78	8.8	///	////	-BCD-FGH
2	40	2.5	493	956.5	12.9	79	9.4	38	2.1	-BCD-FGH
2	45	2.6	506	955.0	13.2	80	9.9	///	////	-BCD-FGH
2	50	2.7	518	953.7	13.3	81	10.2	44	2.1	-BCD-FGH
2	55	2.6	533	952.0	13.7	77	9.8	///	////	-BCD-FGH

Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.80 N 121.80 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 19
RS-number: 108234748
No PTU editing
No wind editing
Started at: 19 MAY 95 18:27 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1013.4	10.5	96	9.9	263	1.4	000000000
0	5	2.7	13	1012.2	11.3	78	7.7	///	////	110100000
0	10	2.6	29	1010.3	11.0	82	8.1	299	1.7	110100000
0	15	3.2	51	1007.7	10.9	85	8.5	///	////	111100000
0	20	3.5	72	1005.1	10.7	88	8.8	281	2.0	111100000
0	25	3.7	95	1002.3	10.6	89	8.9	///	////	111100000
0	30	3.7	115	1000.0	10.5	90	9.0	271	2.2	111100000
0	35	3.9	136	997.4	10.3	90	8.8	///	////	111100000
0	40	3.9	147	996.1	10.3	90	8.8	318	1.3	111100000
0	45	3.7	161	994.4	10.3	90	8.8	///	////	111100000
0	50	3.6	179	992.2	10.1	90	8.6	250	3.2	111100000
0	55	3.4	200	989.8	10.1	90	8.6	///	////	111100000
1	0	3.4	216	987.8	10.0	90	8.5	270	1.4	111100000
1	5	3.3	234	985.7	9.9	90	8.4	///	////	111100000
1	10	3.2	244	984.5	9.8	90	8.3	12	1.2	111100000
1	15	3.3	257	982.9	9.8	90	8.3	///	////	111100000
1	20	3.4	281	980.1	9.7	89	8.0	14	1.1	111100000
1	25	3.4	300	977.9	9.7	89	8.0	///	////	111100000
1	30	3.0	305	977.3	9.6	89	7.9	358	0.6	111100000
1	35	3.4	337	973.5	9.5	89	7.8	///	////	111100000
1	40	3.6	353	971.6	9.4	89	7.7	0	0.0	111100000
1	45	3.5	369	969.8	9.3	89	7.6	///	////	111100000
1	50	3.5	386	967.8	9.1	88	7.3	4	0.5	111100000
1	55	3.3	398	966.4	10.2	91	8.8	///	////	111100000
2	0	3.4	406	965.4	11.6	89	9.9	31	1.0	111100000
2	5	2.6	419	963.9	12.6	86	10.4	///	////	111100000
2	10	3.0	443	961.2	13.3	77	9.4	44	1.1	111100000
2	15	2.6	449	960.5	13.3	75	9.0	///	////	111100000
2	20	2.1	449	960.5	13.2	72	8.3	52	1.5	111100000
2	25	3.1	490	955.8	13.6	69	8.1	///	////	111100000
2	30	3.1	498	954.9	13.7	70	8.4	66	1.2	111100000
2	35	3.4	515	952.9	14.1	71	9.0	///	////	111100000
2	40	2.8	527	951.6	14.6	66	8.4	107	1.2	111100000
2	45	3.2	544	949.6	15.1	64	8.4	///	////	111100000

Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.80 N 122.00 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 20
RS-number: 108234840
No PTU editing
No wind editing
Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.80 N 122.00 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 20
RS-number: 108234753
No PTU editing
No wind editing
Started at: 19 MAY 95 21:31 GMT

Time		AscRate	Hgt/MSL	Pressure	Temp	RH	Dewp	Dir	Speed	WndStat
min	s	m/s	m	hPa	degC	%	degC	deg	m/s	
0	0	0.0	3	1012.3	11.0	95	10.2	275	6.1	000000000
0	5	1.3	9	1011.5	12.4	71	7.3	///	////	111100000
0	10	2.7	30	1009.0	11.8	74	7.4	292	5.8	111100000
0	15	3.3	53	1006.2	11.6	75	7.4	///	////	111100000
0	20	3.5	72	1003.9	11.4	76	7.4	289	6.3	111100000
0	25	3.3	84	1002.4	11.2	78	7.6	///	////	111100000
0	30	3.3	103	1000.2	11.0	79	7.5	294	5.7	111100000
0	35	3.9	125	997.5	10.8	81	7.7	///	////	111100000
0	40	3.8	143	995.3	10.6	81	7.5	293	5.7	111100000
0	45	3.5	157	993.6	10.5	81	7.4	///	////	111100000
0	50	3.3	170	992.2	10.4	82	7.5	296	5.3	111100000
0	55	3.2	182	990.7	10.3	83	7.6	///	////	111100000
1	0	3.0	192	989.5	10.3	82	7.4	298	4.8	111100000
1	5	2.6	204	988.1	10.2	82	7.3	///	////	111100000
1	10	2.4	216	986.6	10.3	81	7.2	298	4.4	111100000
1	15	2.3	229	985.1	10.4	79	7.0	///	////	111100000
1	20	2.4	241	983.7	10.9	79	7.5	292	4.2	111100000
1	25	2.3	251	982.5	11.2	79	7.7	///	////	111100000
1	30	2.2	259	981.6	11.4	79	7.9	292	3.8	111100000
1	35	2.3	274	979.8	11.5	79	8.0	///	////	111100000
1	40	2.3	285	978.5	11.5	79	8.0	285	3.7	111100000
1	45	2.3	298	977.0	11.6	79	8.1	///	////	111100000
1	50	2.2	308	975.8	12.0	77	8.1	279	3.5	111100000
1	55	2.2	318	974.7	13.2	59	5.4	///	////	111100000
2	0	2.3	328	973.5	14.6	43	2.2	276	3.4	111100000
2	5	2.3	340	972.0	15.5	43	3.0	///	////	111100000
2	10	2.1	349	971.1	15.9	57	7.5	273	3.2	111100000
2	15	2.2	363	969.4	16.0	57	7.6	///	////	111100000
2	20	2.2	374	968.2	16.4	52	6.6	275	2.8	111100000

2	25	2.2	385	966.9	16.9	53	7.3	///	////	111100000
2	30	2.3	396	965.7	17.7	45	5.7	277	2.4	111100000
2	35	2.2	407	964.5	18.1	47	6.7	///	////	111100000
2	40	2.3	417	963.3	18.1	47	6.7	282	2.0	111100000
2	45	2.2	428	962.1	18.0	48	6.9	///	////	111100000
2	50	2.2	440	960.7	18.0	49	7.2	284	1.7	111100000
2	55	2.2	450	959.5	17.9	49	7.1	///	////	111100000
3	0	2.2	461	958.4	17.9	49	7.1	285	1.6	111100000
3	5	2.1	470	957.3	18.1	49	7.3	///	////	111100000
3	10	2.0	478	956.5	18.2	48	7.1	296	1.4	111100000
3	15	1.9	488	955.3	18.4	47	7.0	///	////	111100000
3	20	1.9	498	954.2	18.4	46	6.6	306	1.3	111100000
3	25	1.9	509	953.0	18.4	46	6.6	///	////	111100000
3	30	1.9	517	952.1	18.4	45	6.3	301	1.2	111100000
3	35	1.8	525	951.1	18.5	45	6.4	///	////	111100000
3	40	1.9	534	950.2	18.4	44	6.0	283	1.2	111100000
3	45	1.8	542	949.3	18.5	42	5.4	///	////	111100000
3	50	1.8	551	948.4	18.6	41	5.2	285	1.1	111100000
3	55	1.8	561	947.2	18.7	41	5.3	///	////	111100000
4	0	1.7	569	946.3	18.9	42	5.8	288	1.1	111100000
4	5	1.7	575	945.6	19.1	41	5.6	///	////	111100000
4	10	1.7	584	944.7	19.1	38	4.5	283	1.3	111100000
4	15	1.7	592	943.7	19.2	37	4.2	///	////	111100000
4	20	1.7	601	942.8	19.2	37	4.2	281	1.5	111100000
4	25	1.6	609	941.9	19.1	37	4.1	///	////	111100000
4	30	1.5	615	941.2	19.1	36	3.8	271	1.8	111100000
4	35	1.5	620	940.6	19.1	36	3.8	///	////	111100000
4	40	1.6	632	939.4	19.0	36	3.7	265	2.0	111100000
4	45	1.5	638	938.7	18.9	35	3.2	///	////	111100000
4	50	1.5	647	937.8	18.9	35	3.2	259	2.6	111100000
4	55	1.5	653	937.1	18.9	35	3.2	///	////	111100000
5	0	1.5	659	936.4	18.8	35	3.1	256	3.2	111100000
5	5	1.6	668	935.4	18.9	36	3.6	///	////	111100000
5	10	1.3	672	935.0	19.0	35	3.3	252	3.9	111100000
5	15	1.5	681	934.0	19.1	31	1.7	///	////	111100000
5	20	1.3	686	933.4	19.2	28	0.3	253	3.9	111100000
5	25	1.3	694	932.6	19.3	24	-1.7	///	////	111100000
5	30	1.3	699	932.1	19.3	23	-2.3	250	4.0	111100000
5	35	1.2	705	931.4	19.4	19	-4.7	///	////	111100000
5	40	1.3	711	930.7	19.5	18	-5.4	251	4.1	111100000
5	45	1.3	718	930.0	19.5	17	-6.1	///	////	111100000
5	50	1.3	724	929.3	19.5	17	-6.1	247	4.5	111100000
5	55	1.2	730	928.7	19.5	17	-6.1	///	////	111100000

Sounding program REV 7.62 using Loran-C
Ship   :PT_SUR
Location : 36.80 N 122.00 W   3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from   0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 21
RS-number: 108234651
No PTU editing
No wind editing
Started at: 19 MAY 95 21:55 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1013.9	11.0	95	10.2	276	5.8	000000000
0	5	3.0	20	1011.9	12.0	71	7.0	///	////	111100000
0	10	3.5	38	1009.8	11.7	74	7.3	304	6.5	111100000
0	15	3.9	60	1007.1	11.5	76	7.5	///	////	111100000
0	20	3.5	74	1005.3	11.3	77	7.5	308	5.9	111100000
0	25	3.5	93	1003.1	11.1	79	7.6	///	////	111100000
0	30	3.5	109	1001.2	11.0	80	7.7	305	5.7	111100000
0	35	3.5	125	999.2	10.8	81	7.7	///	////	111100000
0	40	3.4	141	997.3	10.6	81	7.5	312	5.4	111100000
0	45	3.2	157	995.3	10.5	82	7.6	///	////	111100000
0	50	3.3	172	993.6	10.4	83	7.7	309	5.1	111100000
0	55	3.3	191	991.3	10.2	85	7.8	///	////	111100000
1	0	3.6	218	988.1	10.0	85	7.6	315	4.6	111100000
1	5	3.9	239	985.5	10.0	84	7.5	///	////	111100000
1	10	4.1	263	982.8	10.3	82	7.4	308	4.1	111100000
1	15	4.0	278	981.0	10.6	80	7.3	///	////	111100000
1	20	4.1	295	978.9	11.1	79	7.6	294	3.7	111100000
1	25	4.0	311	977.0	11.3	81	8.2	///	////	111100000
1	30	3.8	332	974.7	11.4	82	8.5	287	3.5	111100000
1	35	3.6	348	972.7	11.9	80	8.6	///	////	111100000
1	40	3.4	364	970.9	13.8	40	0.5	286	3.2	111100000
1	45	3.4	379	969.2	15.0	41	1.9	///	////	111100000
1	50	3.3	395	967.3	15.6	51	5.6	284	2.7	111100000
1	55	3.3	412	965.4	16.3	53	6.8	///	////	111100000
2	0	3.3	431	963.3	17.3	47	6.0	279	2.5	111100000
2	5	3.2	445	961.7	17.9	49	7.1	///	////	111100000
2	10	3.1	458	960.2	17.9	49	7.1	274	2.5	111100000
2	15	3.0	474	958.4	17.9	49	7.1	///	////	111100000
2	20	3.2	491	956.5	17.8	50	7.3	273	2.3	111100000
2	25	3.2	508	954.5	17.9	49	7.1	///	////	111100000
2	30	3.2	526	952.5	18.1	47	6.7	272	2.2	111100000
2	35	2.9	535	951.6	18.4	45	6.3	///	////	111100000
2	40	2.9	545	950.4	18.7	42	5.6	273	2.1	111100000
2	45	3.2	569	947.8	18.8	41	5.3	///	////	111100000

Sounding program REV 7.62 using Loran-C
Ship   :PT_SUR
Location : 36.70 N 122.40 W   3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from   0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 23
RS-number: 108234843
No PTU editing
No wind editing
Started at: 20 MAY 95 15:19 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1014.9	11.1	87	9.0	326	4.2	000000000
0	5	6.5	31	1011.5	12.1	65	5.8	///	////	111100000
0	10	5.5	58	1008.3	11.6	67	5.7	326	3.7	111100000
0	15	6.0	93	1004.1	11.3	71	6.3	///	////	111100000
0	20	6.0	123	1000.4	10.9	72	6.1	329	3.5	111100000
0	25	6.1	156	996.4	10.7	74	6.3	///	////	111100000
0	30	6.1	186	992.9	10.3	75	6.1	325	3.5	111100000
0	35	5.9	214	989.5	10.1	77	6.3	///	////	111100000
0	40	6.3	247	985.7	9.7	78	6.1	320	3.5	111100000
0	45	5.9	269	983.0	9.5	79	6.1	///	////	111100000
0	50	6.1	305	978.7	9.2	80	6.0	311	3.5	111100000
0	55	5.9	331	975.6	8.9	82	6.0	///	////	111100000
1	0	5.7	356	972.7	8.7	83	6.0	316	3.3	111100000
1	5	5.9	391	968.6	8.4	85	6.1	///	////	111100000
1	10	5.8	420	965.2	8.0	86	5.8	323	3.2	111100000
1	15	6.0	452	961.4	7.8	88	6.0	///	////	111100000
1	20	5.8	480	958.1	7.6	89	5.9	330	3.0	111100000
1	25	5.9	513	954.3	7.4	89	5.8	///	////	111100000
1	30	6.3	544	950.7	7.2	89	5.6	324	2.6	111100000
1	35	6.2	572	947.4	7.0	90	5.5	///	////	111100000
1	40	6.4	613	942.8	6.8	90	5.3	344	2.4	111100000
1	45	5.9	629	941.0	6.7	90	5.2	///	////	111100000
1	50	5.8	655	938.0	6.4	90	4.9	309	1.6	111100000
1	55	6.1	692	933.7	6.1	90	4.6	///	////	111100000
2	0	6.5	738	928.4	6.0	27	-11.5	265	1.9	111100000
2	5	6.0	760	925.9	7.2	19	-14.9	///	////	111100000
2	10	5.7	783	923.5	10.2	14	-16.1	241	1.8	111100000
2	15	5.7	801	921.4	13.2	10	-17.7	///	////	111100000
2	20	5.5	821	919.2	15.3	9	-17.4	237	1.9	111100000
2	25	4.5	830	918.3	15.9	11	-14.5	///	////	111100000
2	30	3.7	848	916.3	16.1	11	-14.3	230	2.1	111100000
2	35	3.6	865	914.5	16.0	11	-14.4	///	////	111100000
2	40	3.3	883	912.5	16.0	10	-15.6	226	2.3	111100000
2	45	3.3	902	910.5	16.0	8	-18.2	///	////	111100000

Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.70 N 122.40 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 24
RS-number: 108234747
No PTU editing
No wind editing
Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.70 N 122.40 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 24
RS-number: 108234747
No PTU editing
No wind editing
Started manually by operator
Started at: 20 MAY 95 17:26 GMT

Time		AscRate	Hgt/MSL	Pressure	Temp	RH	Dewp	Dir	Speed	WndStat
min	s	m/s	m	hPa	degC	%	degC	deg	m/s	
0	0	0.0	3	1015.2	11.2	84	8.6	355	2.3	000000000
0	5	175.5	1057	895.4	15.6	11	-14.7	///	////	000100000
0	10	104.2	1045	896.6	15.8	11	-14.6	///	////	000100000
0	15	64.7	1041	897.0	15.9	11	-14.5	///	////	011100000
0	20	50.9	1021	899.2	16.0	10	-15.6	204	5.6	011100000
0	25	39.0	1017	899.5	16.0	10	-15.6	///	////	111100000
0	30	33.4	1006	900.7	16.0	10	-15.6	211	3.2	111100000
0	35	-2.1	997	901.7	16.0	11	-14.4	///	////	111100000
0	40	-1.8	990	902.5	15.9	11	-14.5	225	4.8	111100000
0	45	-2.1	979	903.6	15.9	11	-14.5	///	////	111100000
0	50	-1.7	969	904.7	16.0	12	-13.3	232	4.1	111100000
0	55	-2.0	960	905.7	16.1	11	-14.3	///	////	111100000
1	0	-1.9	950	906.7	16.1	11	-14.3	222	2.2	111100000
1	5	-1.8	941	907.7	16.2	11	-14.3	///	////	111100000
1	10	-2.0	930	908.9	16.3	11	-14.2	231	2.8	111100000
1	15	-1.9	921	909.8	16.3	11	-14.2	///	////	111100000
1	20	-1.9	913	910.7	16.3	12	-13.1	231	2.0	111100000
1	25	-1.9	902	911.9	16.4	13	-12.0	///	////	111100000
1	30	-1.9	892	912.9	16.4	12	-13.0	232	2.5	111100000
1	35	-2.0	882	914.0	16.5	12	-12.9	///	////	111100000
1	40	-1.8	876	914.7	16.5	12	-12.9	234	3.0	111100000
1	45	-1.8	865	915.8	16.6	12	-12.9	///	////	111100000
1	50	-1.9	855	916.9	16.5	12	-12.9	235	3.2	111100000
1	55	-2.0	844	918.2	16.5	12	-12.9	///	////	111100000

```
Sounding program REV 7.62 using Loran-C
Ship       :PT_SUR
Location : 36.70 N 122.40 W       3 m
Loran-C chain 1:  9940
Phase fitting length is  60 s from   0 min to  10 min
Phase fitting length is 120 s from  10 min to  45 min
Phase fitting length is 240 s from  45 min to 120 min
Sounding : 25
RS-number: 108234749
No PTU editing
No wind editing
Ground check  :    Ref     RS    Corr
  Pressure    : 1016.2 1016.2   -0.0
  Temperature :    22.7   22.7    0.0
  Humidity    :     42     42      0
Started manually by operator
Started at:       20 MAY 95 17:52 GMT
```

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1016.2	11.2	88	9.3	25	1.9	000000000
0	5	0.0	2	1016.3	12.9	73	8.2	///	////	111100000
0	10	-0.2	1	1016.5	12.9	72	8.0	219	2.2	111100000
0	15	-0.1	1	1016.5	12.9	72	8.0	///	////	111100000
0	20	-0.1	1	1016.5	12.8	73	8.1	228	2.8	111100000
0	25	-0.2	1	1016.5	12.8	73	8.1	///	////	111100000
0	30	-0.1	1	1016.5	12.7	73	8.0	234	2.7	111100000
0	35	-0.1	1	1016.5	12.7	74	8.2	///	////	111100000
0	40	0.0	1	1016.5	12.6	74	8.1	242	2.4	111100000
0	45	0.0	1	1016.5	12.6	74	8.1	///	////	111100000
0	50	0.0	1	1016.5	12.6	74	8.1	287	0.8	111100000
0	55	0.1	1	1016.5	12.6	74	8.1	///	////	111100000
1	0	0.0	1	1016.5	12.5	74	8.0	324	1.0	111100000
1	5	-0.1	-2	1016.8	12.5	75	8.2	///	////	111100000
1	10	-0.1	-1	1016.7	12.5	75	8.2	325	1.6	111100000
1	15	-0.1	-2	1016.8	12.4	74	7.9	///	////	111100000
1	20	-0.1	-1	1016.7	12.4	77	8.5	323	1.9	111100000
1	25	-0.1	-1	1016.7	12.3	77	8.4	///	////	111100000
1	30	-0.1	-1	1016.7	12.3	77	8.4	311	2.2	111100000
1	35	0.0	-3	1016.9	12.5	78	8.8	///	////	111100000
1	40	0.1	3	1016.2	12.2	77	8.3	316	2.5	111100000
1	45	0.4	8	1015.6	12.4	77	8.5	///	////	111100000
1	50	0.3	9	1015.5	12.3	76	8.2	318	2.7	111100000
1	55	0.3	8	1015.6	12.4	76	8.3	///	////	111100000
2	0	0.3	9	1015.5	12.6	76	8.5	318	2.7	111100000
2	5	0.4	9	1015.5	12.4	75	8.1	///	////	111100000
2	10	0.1	7	1015.7	12.5	75	8.2	314	2.9	111100000
2	15	0.1	10	1015.3	12.5	76	8.4	///	////	111100000
2	20	-0.1	7	1015.7	12.4	75	8.1	313	3.2	111100000
2	25	-0.1	7	1015.7	12.6	76	8.5	///	////	111100000
2	30	-0.1	7	1015.7	12.6	76	8.5	311	3.2	111100000
2	35	-0.1	5	1016.0	12.7	75	8.4	///	////	111100000
2	40	-0.2	1	1016.5	12.6	75	8.3	312	3.1	111100000
2	45	-0.4	0	1016.6	12.6	75	8.3	///	////	111100000
2	50	-0.3	-1	1016.7	12.9	75	8.6	317	3.1	111100000

```
Sounding program REV 7.62 using Loran-C
Ship      :PT_SUR
Location : 36.70 N 122.40 W      3 m
Loran-C chain 1:  9940
Phase fitting length is  60 s from   0 min to  10 min
Phase fitting length is 120 s from  10 min to  45 min
Phase fitting length is 240 s from  45 min to 120 min
Sounding : 25
RS-number: 108234749
No PTU editing
No wind editing
Ground check  :    Ref     RS   Corr
  Pressure    : 1016.9 1016.9    0.0
  Temperature :   13.3   13.3   -0.0
  Humidity    :     71     71      0
Started manually by operator
Started at:       20 MAY 95 19:54 GMT
```

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1016.9	13.3	71	8.2	124	0.5	000000000
0	5	0.0	3	1016.9	13.2	72	8.3	///	////	111100000
0	10	0.4	7	1016.5	13.1	72	8.2	218	1.2	111100000
0	15	0.0	3	1016.9	13.2	72	8.3	///	////	111100000
0	20	0.0	3	1016.9	13.0	71	7.9	217	1.2	111100000
0	25	0.0	4	1016.8	13.0	72	8.1	///	////	111100000
0	30	0.0	3	1016.9	12.7	70	7.4	218	1.1	111100000
0	35	0.0	2	1017.1	13.0	71	7.9	///	////	111100000
0	40	-0.1	3	1016.9	13.1	71	8.0	216	0.8	111100000
0	45	-0.1	3	1016.9	13.0	71	7.9	///	////	111100000
0	50	0.0	3	1016.9	13.4	72	8.5	208	0.5	111100000
0	55	0.1	4	1016.8	13.2	71	8.1	///	////	111100000
1	0	0.0	3	1016.9	12.9	71	7.8	208	0.6	111100000
1	5	0.0	3	1016.9	12.8	72	7.9	///	////	111100000
1	10	0.0	3	1016.9	12.9	75	8.6	187	0.5	111100000
1	15	0.1	5	1016.7	13.0	73	8.3	///	////	111100000
1	20	0.1	7	1016.5	12.8	71	7.7	119	0.6	111100000
1	25	0.0	5	1016.7	13.1	72	8.2	///	////	111100000
1	30	0.1	7	1016.5	12.9	70	7.6	139	0.6	111100000
1	35	0.2	8	1016.3	12.8	69	7.3	///	////	111100000
1	40	0.1	7	1016.5	12.8	69	7.3	106	0.7	111100000
1	45	0.1	9	1016.2	12.7	70	7.4	///	////	111100000
1	50	0.1	9	1016.2	12.6	70	7.3	133	0.5	111100000
1	55	0.1	7	1016.5	12.7	70	7.4	///	////	111100000
2	0	0.1	9	1016.2	12.6	71	7.5	99	0.8	111100000
2	5	0.1	9	1016.2	12.7	70	7.4	///	////	111100000
2	10	0.3	15	1015.5	12.6	70	7.3	108	0.8	111100000
2	15	0.3	17	1015.2	12.6	72	7.7	///	////	111100000
2	20	0.2	15	1015.5	12.5	72	7.6	95	1.0	111100000
2	25	0.4	18	1015.1	12.5	71	7.4	///	////	111100000
2	30	0.3	17	1015.2	12.5	72	7.6	98	0.7	111100000
2	35	0.3	19	1015.0	12.6	72	7.7	///	////	111100000
2	40	0.2	21	1014.7	12.3	72	7.5	136	0.5	111100000
2	45	0.3	25	1014.2	12.3	72	7.5	///	////	111100000
2	50	0.6	32	1013.5	12.3	72	7.5	112	0.5	111100000

Start Up Date 22 MAY 95 15:42 GMT
System test passed -No errors found
Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.80 N 121.80 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 31
RS-number: 108234842
No PTU editing
No wind editing
Started at: 22 MAY 95 15:52 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1015.1	11.2	94	10.3	279	4.1	000000000
0	5	3.7	23	1012.7	12.1	75	7.9	///	////	111100000
0	10	3.7	40	1010.8	11.9	77	8.0	270	4.4	111100000
0	15	3.4	56	1008.8	11.7	79	8.2	///	////	111100000
0	20	3.3	70	1007.1	11.6	80	8.3	273	4.3	111100000
0	25	3.2	81	1005.7	11.5	81	8.4	///	////	111100000
0	30	3.1	97	1003.9	11.3	82	8.4	277	4.0	111100000
0	35	3.1	115	1001.7	11.2	83	8.5	///	////	111100000
0	40	3.1	133	999.5	11.0	84	8.4	285	3.5	111100000
0	45	3.1	149	997.5	10.9	85	8.5	///	////	111100000
0	50	3.3	168	995.3	10.7	86	8.5	276	3.9	111100000
0	55	3.5	188	992.9	10.5	85	8.1	///	////	111100000
1	0	3.7	208	990.5	10.3	82	7.4	275	4.0	111100000
1	5	4.0	229	987.9	10.2	83	7.5	///	////	111100000
1	10	3.7	245	986.1	10.1	82	7.2	275	3.8	111100000
1	15	3.6	259	984.5	9.9	83	7.2	///	////	111100000
1	20	3.5	273	982.8	9.7	83	7.0	275	3.6	111100000
1	25	3.5	293	980.4	9.6	84	7.1	///	////	111100000
1	30	3.4	311	978.2	9.5	81	6.5	289	2.7	111100000
1	35	3.2	326	976.6	9.5	81	6.5	///	////	111100000
1	40	3.2	340	974.9	9.4	81	6.4	292	2.4	111100000
1	45	3.1	352	973.5	9.3	81	6.3	///	////	111100000
1	50	3.2	370	971.3	9.1	81	6.1	290	2.5	111100000
1	55	3.0	381	970.0	9.0	82	6.1	///	////	111100000
2	0	2.8	394	968.5	8.8	82	5.9	281	2.6	111100000
2	5	2.7	409	966.7	8.7	83	6.0	///	////	111100000
2	10	2.7	422	965.2	8.5	83	5.8	281	2.6	111100000
2	15	2.8	434	963.8	8.5	84	6.0	///	////	111100000
2	20	2.6	447	962.4	8.3	85	6.0	290	2.3	111100000

Sounding program REV 7.62 using Loran-C

Ship :PT_SUR
Location : 36.80 N 121.80 W 3 m

Loran-C chain 1: 9940

Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min

Sounding : 32
RS-number: 108234754

No PTU editing
No wind editing

Started at: 22 MAY 95 17:57 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1016.7	11.4	89	9.7	306	1.6	000000000
0	5	5.8	29	1013.5	12.6	70	7.3	///	////	110100000
0	10	5.1	54	1010.5	12.1	73	7.5	313	4.5	110100000
0	15	5.2	80	1007.3	11.9	74	7.5	///	////	110100000
0	20	4.6	95	1005.6	11.7	75	7.5	326	4.2	110100000
0	25	4.8	123	1002.2	11.4	77	7.6	///	////	110100000
0	30	4.9	150	999.0	11.1	79	7.6	317	4.2	110100000
0	35	4.7	173	996.2	10.9	79	7.5	///	////	110100000
0	40	4.6	192	993.9	10.7	78	7.1	332	4.0	110100000
0	45	4.4	216	991.1	10.6	78	7.0	///	////	110100000
0	50	5.1	247	987.3	10.4	77	6.6	318	3.8	110100000
0	55	4.7	264	985.3	10.3	77	6.5	///	////	110100000
1	0	4.4	282	983.3	10.2	76	6.2	309	3.6	110100000
1	5	4.1	301	981.0	10.2	76	6.2	///	////	110100000
1	10	4.5	326	978.0	10.0	77	6.2	303	3.5	110100000
1	15	4.5	351	975.0	9.7	78	6.1	///	////	110100000
1	20	4.3	375	972.3	9.5	79	6.1	298	3.1	110100000
1	25	4.5	397	969.7	9.4	80	6.2	///	////	110100000
1	30	4.4	415	967.5	9.2	81	6.2	291	3.1	110100000
1	35	4.6	436	965.1	9.0	82	6.1	///	////	110100000
1	40	4.7	467	961.4	8.7	84	6.2	277	3.3	110100000
1	45	4.9	496	958.1	8.5	86	6.3	///	////	111100000
1	50	4.6	512	956.3	8.3	87	6.3	285	2.1	111100000
1	55	4.4	532	953.9	8.1	88	6.3	///	////	111100000
2	0	4.5	550	951.8	8.0	89	6.3	281	1.8	111100000
2	5	4.5	572	949.3	7.8	90	6.3	///	////	111100000
2	10	4.2	592	947.0	7.7	90	6.2	274	1.9	111100000
2	15	3.7	607	945.2	7.6	91	6.3	///	////	111100000
2	20	3.8	626	943.1	7.5	91	6.2	261	2.2	111100000
2	25	3.9	650	940.3	7.4	91	6.1	///	////	111100000
2	30	3.9	668	938.2	7.3	91	6.0	257	2.3	111100000
2	35	3.9	687	936.1	7.2	91	5.9	///	////	111100000
2	40	3.8	706	933.9	7.1	91	5.8	249	2.4	111100000
2	45	3.9	726	931.6	7.0	92	5.8	///	////	111100000

May 23 1600

0	5	4.5	23	1011.5	12.9	69	7.4	///	////	--CD-FGH
0	10	4.7	50	1008.3	12.2	72	7.4	263	2.6	--CD-FGH
0	15	4.6	71	1005.7	12.0	74	7.6	///	////	--CD-FGH
0	20	4.6	95	1002.9	11.7	75	7.5	228	2.3	--CD-FGH
0	25	4.5	115	1000.4	11.6	76	7.6	///	////	--CD-FGH
0	30	4.4	136	998.0	11.3	77	7.5	226	2.3	--CD-FGH
0	35	4.3	153	995.9	11.2	78	7.6	///	////	--CD-FGH
0	40	4.0	170	993.9	11.0	78	7.4	234	2.2	--CD-FGH
0	45	4.0	191	991.3	10.8	79	7.4	///	////	--CD-FGH
0	50	3.8	209	989.3	10.6	80	7.3	231	2.2	--CD-FGH
0	55	3.9	230	986.7	10.4	81	7.3	///	////	-BCD-FGH
1	0	3.7	247	984.7	10.2	81	7.1	222	2.2	-BCD-FGH
1	5	4.3	276	981.2	10.0	83	7.3	///	////	-BCD-FGH
1	10	4.3	298	978.7	9.7	84	7.2	230	2.0	-BCD-FGH
1	15	4.1	315	976.7	9.6	86	7.4	///	////	-BCD-FGH
1	20	4.0	330	974.9	9.5	86	7.3	214	2.1	-BCD-FGH
1	25	3.8	350	972.5	9.4	87	7.4	///	////	-BCD-FGH
1	30	3.8	362	971.1	9.2	87	7.2	226	1.8	-BCD-FGH
1	35	3.9	394	967.4	9.1	87	7.1	///	////	-BCD-FGH
1	40	3.8	413	965.2	9.0	87	7.0	228	1.6	-BCD-FGH
1	45	4.0	436	962.5	8.9	88	7.1	///	////	-BCD-FGH
1	50	4.2	457	960.0	8.8	88	7.0	233	1.5	-BCD-FGH
1	55	4.4	471	958.4	8.7	88	6.9	///	////	-BCD-FGH
2	0	4.5	497	955.3	8.6	88	6.8	240	1.3	-BCD-FGH
2	5	4.0	517	953.1	8.5	88	6.7	///	////	-BCD-FGH
2	10	4.5	548	949.5	8.4	88	6.6	253	1.1	-BCD-FGH
2	15	4.4	567	947.3	8.3	88	6.5	///	////	-BCD-FGH
2	20	4.6	594	944.2	8.1	88	6.3	259	1.0	-BCD-FGH
2	25	4.3	612	942.1	8.1	88	6.3	///	////	-BCD-FGH
2	30	4.7	638	939.1	7.9	87	5.9	273	0.8	-BCD-FGH
2	35	4.3	647	938.1	7.9	87	5.9	///	////	-BCD-FGH
2	40	4.3	678	934.6	8.3	89	6.6	303	0.8	-BCD-FGH
2	45	4.7	708	931.3	9.8	90	8.3	///	////	-BCD-FGH
2	50	4.2	721	929.8	10.5	90	9.0	331	1.1	-BCD-FGH
2	55	4.2	737	928.0	10.8	90	9.3	///	////	-BCD-FGH
3	0	3.9	755	925.9	10.8	87	8.8	345	1.5	-BCD-FGH
3	5	4.2	772	924.0	10.8	85	8.4	///	////	-BCD-FGH
3	10	3.6	786	922.6	11.1	85	8.7	350	1.9	-BCD-FGH
3	15	3.6	811	919.7	11.6	84	9.0	///	////	-BCD-FGH
3	20	3.8	835	917.2	12.1	82	9.2	356	2.6	-BCD-FGH
3	25	3.8	847	915.8	12.2	80	8.9	///	////	-BCD-FGH
3	30	3.6	863	914.0	12.3	79	8.8	6	2.9	-BCD-FGH
3	35	3.7	883	911.8	12.3	80	9.0	///	////	-BCD-FGH
3	40	3.7	896	910.5	12.5	81	9.4	6	3.5	-BCD-FGH
3	45	3.4	914	908.5	12.7	81	9.6	///	////	-BCD-FGH
3	50	3.3	933	906.5	12.8	80	9.5	6	4.0	-BCD-FGH
3	55	3.5	953	904.3	13.0	80	9.7	///	////	-BCD-FGH
4	0	3.9	980	901.4	13.0	81	9.9	5	4.4	-BCD-FGH
4	5	3.4	991	900.2	12.9	80	9.6	///	////	-BCD-FGH
4	10	3.7	1008	898.3	12.8	79	9.3	360	5.5	-BCD-FGH
4	15	4.0	1040	894.9	13.1	79	9.6	///	////	-BCD-FGH
4	20	4.7	1074	891.3	13.0	80	9.7	359	6.1	-BCD-FGH
4	25	4.5	1091	889.5	13.0	79	9.5	///	////	-BCD-FGH
4	30	4.0	1100	888.5	13.1	74	8.6	358	6.8	-BCD-FGH
4	35	4.5	1121	886.3	13.1	72	8.2	///	////	-BCD-FGH
4	40	4.4	1141	884.2	13.3	72	8.4	357	7.1	-BCD-FGH

Sounding program REV 7.62 using Loran-C
Ship   :PT_SUR
Location : 36.80 N 121.80 W   3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from   0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 35
RS-number: 108234749
No PTU editing
No wind editing
Start Up Date 23 MAY 95 16:57 GMT
System test passed -No errors found
Sounding program REV 7.62 using Loran-C
Ship   :PT_SUR
Location : 36.80 N 121.80 W   3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from   0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 35
RS-number: 108234749
No PTU editing
Started manually by operator
Started at: 23 MAY 95 17:05 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1015.0	12.7	76	8.6	184	0.7	000000000
0	5	-0.7	-1	1015.5	12.8	77	8.9	134	2.6	111100000
0	10	-0.6	-3	1015.7	12.7	78	9.0	109	3.6	111100000
0	15	-0.3	-2	1015.6	12.8	79	9.3	97	3.9	111100000
0	20	-0.2	-1	1015.5	12.7	78	9.0	86	3.9	111100000
0	25	-0.1	2	1015.1	12.8	78	9.1	82	3.6	111100000
0	30	-0.1	1	1015.2	12.7	78	9.0	82	3.2	111100000
0	35	0.1	2	1015.1	12.7	78	9.0	85	2.9	111100000
0	40	0.1	1	1015.2	12.6	78	8.9	90	2.4	111100000
0	45	0.1	2	1015.1	12.7	79	9.2	95	2.1	111100000
0	50	0.1	1	1015.2	12.7	78	9.0	100	1.7	111100000
0	55	0.0	2	1015.1	12.7	79	9.2	100	1.8	111100000
1	0	0.1	3	1015.0	13.1	79	9.6	101	1.6	111100000
1	5	0.1	6	1014.6	13.2	78	9.5	103	1.5	111100000
1	10	0.2	7	1014.5	13.3	77	9.4	103	1.4	111100000
1	15	0.1	8	1014.3	13.5	77	9.6	103	1.3	111100000
1	20	0.1	5	1014.7	14.0	76	9.9	101	1.2	111100000
1	25	0.2	7	1014.5	13.6	76	9.5	99	1.1	111100000
1	30	0.2	9	1014.2	13.0	75	8.7	96	1.0	111100000
1	35	0.3	12	1013.8	12.6	77	8.7	95	1.0	111100000
1	40	0.1	11	1014.0	12.5	77	8.6	94	1.0	111100000
1	45	0.3	14	1013.6	12.4	79	8.9	93	1.0	111100000
1	50	0.3	15	1013.5	12.4	81	9.3	93	0.9	111100000
1	55	0.2	13	1013.7	12.3	81	9.2	93	0.9	111100000
2	0	0.1	13	1013.7	12.2	80	8.9	93	0.9	111100000
2	5	-0.1	12	1013.8	12.3	81	9.2	93	0.9	111100000
2	10	0.0	11	1014.0	12.3	81	9.2	94	0.9	111100000

Sounding program REV 7.62 using Loran-C
Ship :PT_SUR
Location : 36.80 N 121.86 W 3 m
Loran-C chain 1: 9940
Phase fitting length is 60 s from 0 min to 10 min
Phase fitting length is 120 s from 10 min to 45 min
Phase fitting length is 240 s from 45 min to 120 min
Sounding : 36
RS-number: 108234749
No PTU editing
Started manually by operator
Started at: 23 MAY 95 19:16 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	1015.8	12.6	86	10.3	269	3.0	000000000
0	5	0.0	2	1015.8	12.6	85	10.2	243	2.0	111100000
0	10	0.0	3	1015.7	12.6	84	10.0	219	1.4	111100000
0	15	0.0	4	1015.6	12.6	84	10.0	215	1.1	111100000
0	20	0.0	3	1015.7	12.6	84	10.0	199	0.8	111100000
0	25	-0.1	1	1016.0	12.5	84	9.9	165	0.6	111100000
0	30	-0.1	1	1016.0	12.8	84	10.2	116	0.5	111100000
0	35	-0.1	-1	1016.2	12.4	85	10.0	109	0.5	111100000
0	40	-0.1	-1	1016.2	12.4	85	10.0	112	0.5	111100000
0	45	0.1	4	1015.6	12.8	85	10.4	103	0.5	111100000
0	50	0.1	7	1015.2	12.6	85	10.2	78	0.6	111100000
0	55	0.2	8	1015.1	12.8	84	10.2	68	0.7	111100000
1	0	0.1	5	1015.5	12.6	84	10.0	56	0.6	111100000
1	5	0.3	6	1015.3	12.5	85	10.1	42	0.5	111100000
1	10	0.2	5	1015.5	12.4	84	9.8	0	0.0	111100000
1	15	-0.1	5	1015.5	12.5	85	10.1	0	0.0	111100000
1	20	0.1	9	1015.0	12.6	85	10.2	0	0.0	111100000
1	25	0.1	12	1014.6	12.4	84	9.8	0	0.0	111100000
1	30	0.4	17	1014.0	12.1	85	9.7	0	0.0	111100000
1	35	0.5	22	1013.4	12.0	85	9.6	0	0.0	111100000
1	40	0.7	25	1013.0	12.0	85	9.6	0	0.0	111100000
1	45	1.0	35	1011.9	11.9	86	9.7	0	0.0	111100000
1	50	1.0	40	1011.3	11.8	86	9.6	328	0.5	111100000
1	55	1.2	46	1010.5	11.8	86	9.6	332	0.5	111100000
2	0	1.2	54	1009.5	11.7	86	9.5	332	0.5	111100000
2	5	1.3	60	1008.8	11.7	87	9.7	326	0.5	111100000
2	10	1.3	64	1008.3	11.6	87	9.6	320	0.5	111100000
2	15	1.3	73	1007.2	11.5	87	9.5	314	0.5	111100000
2	20	1.2	76	1006.8	11.5	87	9.5	0	0.0	111100000
2	25	1.1	81	1006.2	11.4	88	9.5	0	0.0	111100000
2	30	0.9	82	1006.1	11.4	88	9.5	0	0.0	111100000
2	35	1.0	89	1005.3	11.3	88	9.4	0	0.0	111100000
2	40	1.0	95	1004.6	11.3	88	9.4	0	0.0	111100000
2	45	1.0	103	1003.6	11.2	88	9.3	0	0.0	111100000

Sounding program REV 7.62 using Omega
Ship :PT_SUR
Location : 36.77 N 121.90 W 3 m
Rejected Sigma stations: a,b,c
Phase fitting length is 250 s from 0 min to 120 min
Sounding : 37
RS-number: 309140455
No PTU editing
No wind editing
Started at: 23 MAY 95 21:06 GMT

Time min	s	AscRate m/s	Hgt/MSL m	Pressure hPa	Temp degC	RH %	Dewp degC	Dir deg	Speed m/s	WndStat
0	0	0.0	3	104.3	11.9	93	10.8	236	1.9	--------
0	5	-461.8	//////	1011.4	12.9	76	8.8	///	////	--CD--GH
0	10	-277.1	//////	1009.0	12.3	80	9.0	190	2.3	--CD--GH
0	15	-173.2	//////	1005.6	12.0	83	9.3	///	////	--CD--GH
0	20	-138.6	//////	1002.9	11.8	84	9.2	201	1.9	--CD--GH
0	25	-106.6	//////	998.9	11.6	85	9.2	///	////	--CD--GH
0	30	-92.4	//////	997.0	11.4	86	9.2	244	1.5	--CD--GH
0	35	0.0	//////	994.8	11.2	87	9.2	///	////	--CD-FGH
0	40	0.0	//////	992.7	11.0	88	9.1	249	1.6	--CD-FGH
0	45	0.0	//////	991.2	10.9	89	9.2	///	////	--CD-FGH
0	50	0.0	//////	989.5	10.7	89	9.0	285	2.2	--CD-FGH
0	55	0.0	//////	987.0	10.6	90	9.1	///	////	--CD-FGH
1	0	0.0	//////	984.5	10.4	91	9.0	260	1.6	--CD-FGH
1	5	0.0	//////	983.3	10.3	92	9.1	///	////	--CD-FGH
1	10	0.0	//////	981.1	10.1	93	9.1	257	1.5	--CD-FGH
1	15	0.0	//////	979.1	10.0	94	9.1	///	////	--CD-FGH
1	20	0.0	//////	977.0	9.9	95	9.2	255	1.6	--CD-FGH
1	25	0.0	//////	974.3	9.7	96	9.1	///	////	--CD-FGH
1	30	0.0	//////	970.6	9.6	96	9.0	296	2.6	--CD-FGH
1	35	0.0	//////	967.8	9.5	96	8.9	///	////	--CD-FGH
1	40	0.0	//////	964.7	9.3	97	8.9	304	3.1	--CD-FGH
1	45	0.0	//////	962.7	9.2	96	8.6	///	////	--CD-FGH
1	50	0.0	//////	959.1	9.0	96	8.4	311	3.9	--CD-FGH
1	55	0.0	//////	956.4	9.0	97	8.6	///	////	--CD-FGH
2	0	0.0	//////	953.7	8.8	97	8.4	311	3.9	--CD-FGH
2	5	0.0	//////	950.3	8.7	97	8.3	///	////	--CD-FGH
2	10	0.0	//////	946.7	9.1	98	8.8	314	4.1	--CD-FGH
2	15	0.0	//////	944.2	10.0	99	9.9	///	////	--CD-FGH
2	20	0.0	//////	942.1	10.3	98	10.0	316	4.6	--CD-FGH
2	25	0.0	//////	940.3	10.5	94	9.6	///	////	--CD-FGH
2	30	0.0	//////	938.5	10.6	92	9.4	319	5.0	--CD-FGH
2	35	0.0	//////	936.2	11.2	95	10.5	///	////	--CD-FGH
2	40	0.0	//////	933.4	12.5	95	11.8	319	4.8	--CD-FGH
2	45	0.0	//////	932.0	13.0	93	11.9	///	////	--CD-FGH
2	50	0.0	//////	930.0	13.2	91	11.8	322	5.6	--CD-FGH
2	55	0.0	//////	927.4	13.3	88	11.4	///	////	--CD-FGH

APPENDIX J. MATLAB CODE FOR COMPUTATION

A. GPS, ELEVATION AND AZIMUTH ANGLE CALCULATION

```
% GPS & elevation & azimuth angle caculation
% File name gps.m

ship_longitude=121.81;
ship_latitude=36.81;
sensor_longitude=121.8;
sensor_latitude=36.8;
heading=120;

dx=(ship_longitude-sensor_longitude)*47.995;
dy=(ship_latitude-sensor_latitude)*59.97;

a=(atan(abs(dx/dy)))*57.3

if dy>0
  if heading>(180-a)
    bearing=(heading-180+a);
   else
    bearing=180-a-heading
  end
 else
  if heading<a
    bearing=a-heading;
   else
    bearing=heading-a;
  end
end

if bearing<90
  phi=(90-bearing)/57.3
 else
  phi=(180-bearing)/57.3
end

range_in_nmi=sqrt(dx*dx+dy*dy)
range_in_km=(range_in_nmi)*1.852
```

```
theta=atan(0.0032/range_in_nmi)

l=41.5;                 %ship length
w=9.75;                 %ship width
h=8.8;                  %ship height

Area=l*w*sin(theta)+h*w*cos(theta)*sin(phi)+h*l*cos(theta)*cos(phi)
```

B. MRT &MDT vs Spatial Frequency

```
% MRT & MDT vs Spatial Frequency
% File name drt_fre

SNRT=2.5;          % Shumaker Example 8-13
NET=0.125;
dx=0.25;
dy=0.25;
L=7;
Te=0.1;
Fr=30;
Nos=1;
Nss=1;
rb=0.335;
rs=0.456;

v=0.000001:0.25:3.000001;
MTF=[1 0.89 0.79 0.64 0.53 0.43 0.35 0.27 0.2 0.15 0.1 0.07 0.04];

omigaT=1./(4*v.*v);
ROx=(1+(2*2*v.*v*rb.*rb)).^(-0.5);

MRT=2*SNRT*NET*(ROx.^0.5).*((v.*v*dx*dy/L).^0.5).*((Te*Fr*Nos*Nss)^(-
0.5))./MTF;

MDT_1=SNRT*NET*(omigaT+rs*rs)*((dx*dy)^0.5);
MDT_2=omigaT.*(( ((pi/4)*(rs*rs+rb*rb+omigaT)*Te*Fr*Nos*Nss)).^0.5);
MDT=MDT_1./MDT_2;

plot(v,MDT,v,MRT);
title('MRT & MDT vs Spatial Frequency');
xlabel('Spatial Frequency');
ylabel('Temperature');
gtext('MRT');
gtext('MDT');
grid;
```

C. MRT, MDT & ΔT vs Range for Detection

```
% MRT & MDT vs & Range
% N=1 for Detection
% File name r_n_1_f

SNRT=2.5;                  % Shumaker Example 8-13
NET=0.125;
dx=0.25;
dy=0.25;
L=7;
Te=0.1;
Fr=30;
Nos=1;
Nss=1;
rb=0.335;
rs=0.456;

N=1;                       % physical dimension
At=214.4513;
Dc=(At)^(0.5);
X=Dc/N;

dt=3.387144;
u=0.0002132;

v=0.000001:0.25:3.000001;
MTF=[1 0.89 0.79 0.64 0.53 0.43 0.35 0.27 0.2 0.15 0.1 0.07 0.04];

Range=v*2000*X;
omigaT=1./(4*v.*v);
ROx=(1+(2*2*v.*v*rb.*rb)).^(-0.5);

tau=exp(-u.*Range);
dtapp=dt*tau;

MRT=2*SNRT*NET*(ROx.^0.5).*((v.*v*dx*dy/L).^0.5).*((Te*Fr*Nos*Nss)^(-
0.5))./MTF;

MDT_1=SNRT*NET*(omigaT+rs*rs)*((dx*dy)^0.5);
MDT_2=omigaT.*(( ((pi/4)*(rs*rs+rb*rb+omigaT)*Te*Fr*Nos*Nss)).^0.5);
MDT=MDT_1./MDT_2;
```

```
plot(Range,MDT,Range,MRT,Range,dtapp);
title('MRT, MDT & dT  vs Range for Detection');
xlabel('Range (m)');
ylabel('Temperature');
gtext('MRT');
gtext('MDT');
grid;
```

D. MRT & ΔT vs Range for Classificaton

```
% MRT & dt vs Range
% N=8 for Classification
% File name r_n_8_f

SNRT=2.5;                    % Shumaker Example 8-13
NET=0.125;
dx=0.25;
dy=0.25;
L=7;
Te=0.1;
Fr=30;
Nos=1;
Nss=1;
rb=0.335;
rs=0.456;

N=8;                         % physical dimension
At=214.4513;
Dc=(At)^(0.5);
X=Dc/N;

dt=3.387144;
u=0.0002132;

v=0.000001:0.25:3.000001;
MTF=[1 0.89 0.79 0.64 0.53 0.43 0.35 0.27 0.2 0.15 0.1 0.07 0.04];

Range=v*2000*X;
omigaT=1./(4*v.*v);
ROx=(1+(2*2*v.*v*rb.*rb)).^(-0.5);

tau=exp(-u.*Range);
dtapp=dt*tau;

MRT=2*SNRT*NET*(ROx.^0.5).*((v.*v*dx*dy/L).^0.5).*((Te*Fr*Nos*Nss)^(-
0.5))./MTF;

MDT_1=SNRT*NET*(omigaT+rs*rs)*((dx*dy)^0.5);
MDT_2=omigaT.*(( ((pi/4)*(rs*rs+rb*rb+omigaT)*Te*Fr*Nos*Nss)).^0.5);
MDT=MDT_1./MDT_2;
```

```
plot(Range,MRT,Range,dtapp);
title('MRT & dT vs Range for Classification');
xlabel('Range (m)');
ylabel('Temperature');
gtext('MRT');
grid;
```

E. MRTD AND ΔT VS RANGE FOR IDENTIFICATION

```
% MRT & dT vs Range
% N=12.8 for Identification
% File name r_n_128_f

SNRT=2.5;                    % Shumaker Example 8-13
NET=0.125;
dx=0.25;
dy=0.25;
L=7;
Te=0.1;
Fr=30;
Nos=1;
Nss=1;
rb=0.335;
rs=0.456;

N=12.8;                      % physical dimension
At=214.4513;
Dc=(At)^(0.5);
X=Dc/N;

dt=3.387144;
u=0.0002132

v=0.000001:0.25:3.000001;
MTF=[1 0.89 0.79 0.64 0.53 0.43 0.35 0.27 0.2 0.15 0.1 0.07 0.04];

Range=v*2000*X;
omigaT=1./(4*v.*v);
ROx=(1+(2*2*v.*v*rb.*rb)).^(-0.5);

tau=exp(-u.*Range);
dtapp=dt*tau;

MRT=2*SNRT*NET*(ROx.^0.5).*((v.*v*dx*dy/L).^0.5).*((Te*Fr*Nos*Nss)^(-
0.5))./MTF;

MDT_1=SNRT*NET*(omigaT+rs*rs)*((dx*dy)^0.5);
MDT_2=omigaT.*(( ((pi/4)*(rs*rs+rb*rb+omigaT)*Te*Fr*Nos*Nss)).^0.5);
MDT=MDT_1./MDT_2;
```

```
plot(Range,MRT,Range,dtapp);
title('MRT & dT vs Range for Identification');
xlabel('Range (m)');
ylabel('Temperature');
gtext('MRT');
grid;
```

LIST OF REFERENCES

1. David G. Moretz, *Analysis of Target Contrast Improvement Using Polarization Filtering in The Infrared Region*, MS Thesis, Naval Postgraduate School, December, 1994.

2. Zeisse C.R., *SeaRad, A Sea Radiance Prediction Code*, Technical Report 1702, Naval Command, Control and Ocean Surveillance Center, RDT and E Division, November 1995.

3. Shumaker, David L., J.T. Wood and C. R. Thacker, *Infrared Imaging Systems Analysis,* The Environmental Research Institute of Michigan, 1993.

4. Khalil Seyrafi and S. A. Hovanessian, *Introduction to Electro-Optical Imaging and Tracking Systems.* Artech House, Inc. MA, 1993.

5. William L. Wolfe and George J. Zissis, *The Infrared Handbook,* Office of Naval Research, Department of the Navy, Washington, DC, 1978.

6. Alan Chappell, *Optoelectronics Theory and Practice,* Texas Instruments Ltd.1978.

7. Cooper, A.W. and E.C. Crittenden, Jr, *Electro-Optic Sensors and Systems*, Naval Postgraduate School, Monterey, CA, 1995.

8. Gerald C. Holst, *Electro-Optical Imaging System Performance*, JCD Publishing, FL, 1995.

9. Cooper, A. W., *EOMET95-Spring Cruise Plan*, Naval Postgraduate School, May 1995.

INITIAL DISTRIBUTION LIST

No. Copies

1. Defense Technical Information Center..2
   8725 John J. Kingman Rd., STE 0944
   Ft. Belvoir, VA 22060-6218

2. Dudley Knox Library..2
   Naval Postgraduate School
   411 Dyer Rd.
   Monterey, CA 93943-5101

3. Professor Alfred W. Cooper..2
   Code PH/Cr
   Naval Postgraduate School
   Monterey, CA 93943-5101

4. Prefessor David D. Cleary...1
   Code PH/Cl
   Naval Postgraduate School
   Monterey, CA 93943-5101

5. Dr. A. Goroch 1
   Bldg 704-255
   Naval Research Laboratory
   Monterey, CA 93943-5502

6. Naval Command Control and Ocean Surveillance Center.......................1
   RDT&E Division
   ATTN : DR. J.H. Richter, Code 54
   53570 Silvergate Ave.
   San Diego, CA 92152-5230

7. Naval Command Control and Ocean Surveillance Center.......................1
   RDT&E Division
   ATTN : Dr. C. R. Zeisse, Code 543
   53570 Silvergate Ave.
   San Diego, CA 92152-5230

8. Yu, Chih-Li...3